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UNIVERSITIES FOR DEVELOPMENT: REPORT OF THE JOINT INDO-U.S. IMPACT EVALUATION OF THE INDIAN AGRICULTURAL UNIVERSITIES

A.I.D. PROJECT IMPACT EVALUATION NO. 68

by

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Bibliography

PREFACE

From the mid-1950s to the mid-1970s, the U.S. Agency for International Development (A.I.D) collaborated with many developing countries in their establishment of agricultural universities and colleges. These institutions have since become a major source of leadership and manpower for agricultural development in the Third World.

There is now a revival of interest in agricultural higher education. Worldwide, new and established agricultural universities and faculties are seeking to adapt and enhance their role in a national and global context of rapid technological and economic change. Because of this renewed interest, the A.I.D. Center for Development Information and Evaluation (CDIE) began a long-term study in 1985 of agricultural universities in the developing world. This worldwide study ultimately seeks to identify lessons that can be learned and applied to future development investments in higher agricultural education.

The CDIE study has involved extensive field visits and dialogue with university leaders and university client groups in India, Indonesia, Thailand, Brazil, Dominican Republic, Mexico, Ethiopia, Malawi, Morocco, and Nigeria. Faculty from the U.S. land-grant system have been used extensively in conducting the individual studies.

In 1986, CDIE initiated discussions with the Indian Council for Agricultural Research (ICAR) about India's participation in the worldwide study. After several meetings with the ICAR leadership and the vice-chancellors of the state agricultural universities, agreement was reached on the basic research design to be used in conducting the study of India's state agricultural university.

The study of India's state agricultural universities (SAUs) is of particular interest given that the Government of India sought to adapt the U.S. land-grant model in the development of a national system for agricultural higher education. From 1955 to 1972, A.I.D. contracted with several U.S. land-grant universities in assisting the Indian Government in establishing eight agricultural universities. The U.S. land-grant universities included Ohio State University, the University of Illinois, the University of Missouri, Pennsylvania State University, Kansas State University and the University of Tennesse. Through this cooperative effort, many Indian faculty received advanced degrees at U.S. universities and large numbers of faculty from U.S. land-grant universities were able to work in India to assist in the early development of its SAUs.

The establishment of the initial eight universities laid the foundation for the present national, state-based system of 28

agricultural universities.

The field studies for this report were undertaken in India in 1987. Five interdisciplinary review teams were recruited, primarily from U.S. land-grant universities and A.I.D., to visit 10 universities in India. Each team, consisting of five to six social and agricultural scientists, was able to visit two universities, spending approximately 10 days at each of the campuses. A report on each university was then prepared by the respective review team. Based on these 10 reports, a larger synthesis of the study findings is presented in the present report.

In early 1988, a draft of this report was submitted to ICAR, and on May 21-22, an ICAR-sponsored workshop was held in New Delhi to review the report. The workshop was led by Dr. N.S. Randhawa, Director General of ICAR; Dr. Maharaj Singh, Deputy Director General of ICAR; and Dr. K.V. Raman, Director of the National Academy of Agricultural Research Management in Hyderabad.

All of the 28 SAUs participated in the workshop and were represented either at the vice chancellor or director of research level. Members of the USAID/New Delhi staff were also present, as were the author of this report and Dr. Leo Walsh (Dean, College of Agriculture at the University of Wisconsin), who attended as a member of the Board for International Food and Agricultural Development (BIFAD).

Although many issues were vigorously debated at this workshop, several policy areas received particular attention. These included the need for the SAUs to establish an interdisciplinary, systems-oriented approach to research and education; the reorientation of the SAUs toward rural development in its broadest sense; the development of larger and stronger social science programs on the SAU campuses and their integration with technical disciplines; the establishment of better relations between the SAUs and other agricultural development organizations at the state level, including the state departments of irrigation, the strengthening of the Indian Agricultural Universities Association; and the decentralization of the SAU system.

At the conclusion of the workshop, Director General Dr. Randhawa announced his intention of establishing a group to (1) review this synthesis report and a similar, recently released internal review of ICAR, and (2) make proposals for implementing the recommendations in these reports.

As a result of the workshop, the United States and India are interested in exploring the possibility of reestablishing a relationship between the Indian and the U.S. land-grant universities. This relationship would entail a collaboration between Indian educators and scientists and their American counterparts in addressing major issues in agricultural and rural development.

To initiate further action on this potential collaboration, a meeting was held in Chicago on July 8, 1988, with representatives from U.S. land-grant universities in attendance. This meeting resulted in the formation of a working group of land-grant representatives who will formulate a plan of action for further discussions with ICAR to identify new areas of long-term collaboration between the United States and India.

ACKNOWLEDGMENTS

This report would not have been possible without the work of the members of five interdisciplinary review teams, most of whom spent approximately 1 month visiting two universities each; the leadership and management of Dr. Gary Hansen, the Center for Development Information and Evaluation (CDIE) project director in A.I.D./Washington; and the support of Dr. Ronald Pollock of USAID/New Delhi, who was particularly instrumental in setting up appointments at each of the universities, accompanying the teams on their trips, and maintaining the study's momentum. The five review teams consisted of Drs. Guy Baird (Winrock International), Richard Bawden (Hawkesbury Agricultural College), Lin Compton (University of Wisconsin), John Dunbar (Kansas State University), William Easter (University of Minnesota), Russell Freed (Michigan State University), Gary Hansen (A.I.D./Washington), Charles Hatch (University of Idaho), LaRue Johnson (Colorado State University), Harry Kunkel (Texas A&M University), William B. Lacy (University of Kentucky), Jim Lowenthal (A.I.D. /Washington), Robert Macadam (Hawkesbury Agricultural College), Hunt McCauley (private consultant), David Meers (Rutgers University), Peter Oram (International Food Policy Research Institute), Edward Price (Oregon State University), Jack Rutledge (University of Wisconsin), Holly Sims (University of California, Berkeley), Paul Thompson (Texas A&M University), Tom Yuill (University of Wisconsin), and Robert Werge (U.S. Department of Agriculture). Other participants included John Becker (USAID/New Delhi), Paula Goddard (A.I.D./CDIE), and Surgan Singh (USAID/New Delhi). The work of the teams, in turn, was only possible because of the excellent cooperation and support provided by the vice-chancellors, deans, faculties, staffs, and other personnel of the state agricultural universities. Drs. O.P. Gautam, Maharaj Singh, and K.V. Raman reviewed the draft manuscript with great care. Finally, the cooperation and continuing discussion with the Director-General of the Indian Council for Agricultural Research, Dr. N.S. Randhawa, and the openness displayed by Dr. Maharaj Singh deserve special mention. They set the stage for a true dialogue.

SUMMARY

This study is part of a larger study by A.I.D.'s Center for Development Information and Evaluation (CDIE) of the achievements of agricultural universities worldwide and their impacts on agriculture in developing countries. The study was undertaken in

order (1) to examine the impact of the state agricultural universities (SAUs) on Indian agriculture; (2) to improve the effectiveness of those universities through the findings of the study; (3) to evaluate the role of the United States in supporting the development of India's SAU system, and (4) to provide a basis for future donor relationships with the SAUs. The study documents the historical development of the SAUs; their current structure; their conformity with the Indian Council for Agricultural Research (ICAR) Model Act; their major achievements to date; the factors contributing to these achievements; the impacts of the SAUs on agriculture; problems, opportunities, and issues now facing them given the changing nature of world agriculture; and their future directions.

The achievements and impacts of the SAU system in India have been substantial, especially given the short period of their existence. However, India has had little growth in grain production over this decade. Moreover, all nations are now facing a rapidly changing world agriculture. In a volatile world market for agricultural commodities of all kinds, new technological changes can make previously distinct commodities interchangeable, such as the substitutability of palm, coconut, and soy oil in the manufacture of bread. In some cases, the higher levels of agricultural production have been accompanied by severe environmental deterioration, including soil erosion, aquifer depletion, deforestation, chemical pollution, and destruction of wildlife habitats. Finally, the linkages between agriculture, industry, and the service sector are being reexamined as the problem of finding employment and income for all has taken on global proportions.

Given these changes in world agriculture, this report takes a somewhat different approach than have others conducted in recent years. Our approach is not to focus simply on the technical problems or course requirements of the SAU system, but on what we see as issues of greater magnitude. Like the authors of the University Education Commission report of 1949 (1962), we believe that the concept of mission or purpose should be our central concern. However, we have attempted to go beyond that document by asking how the very process of examining purposes and missions in light of an ever-changing socioeconomic and technological environment might itself become a mission incorporated by all agricultural universities. Thus, although the report of necessity discusses specific issues, we have attempted to focus on the SAU system as a whole rather than on its parts.

India became an independent nation just 40 years ago. In these 40 years it has achieved remarkable progress. Much of that progress is attributable in part to the role of the SAU system, a system that was initiated only in 1960. Indeed, not too long ago it was common to hear that India was on the verge of mass starvation, that the nation was in hopeless economic stagnation, and that it would always be a nation bound by ancient traditions without relevance to the present or future. Today, few people of any political persuasion would make such statements.

From 1952 to 1972, the six land-grant universities of Illinois, Kansas State, Missouri, Ohio State, Pennsylvania State, and Tennessee entered into agreements to assist the Government of India in developing eight agricultural universities in India at an approximate total cost of $31 million in U.S. dollars and $11 million in U.S.-owned rupees. During the 20 years of cooperation, 337 U.S. faculty members were assigned to posts in India and more than 1,000 Indian students received M.Sc. and/or Ph.D. degrees from these same U.S. universities.

Today, India boasts 28 SAUs (several states have more than one), the Indian Veterinary Research Institute, and the Indian Agricultural Research Institute (IARI) (the latter two organizations award only postgraduate degrees). Each SAU is a state institution that receives funds from its respective state, the central Government, and other sources (e.g., grants, contracts, and proceeds from foundation seed and farm product sales). Each university is directed by a board of management. A chancellor, who is also the governor of the state, is the nominal head of the university. The vice-chancellor reports to the board and handles the daily operations of the university. Each university has several colleges, the deans of which report to the vice-chancellor. There are also deans for teaching, research, and extension education, who administer the university education, research, and extension education programs, respectively.

In 1966, ICAR developed the Model Act to help the states establish their agricultural universities in accordance with national goals and priorities. However, several issues have arisen that affect the literal implementation of the Model Act by the various states. These issues include (1) the establishment of multiple SAUs within a state, (2) ICAR policy toward the SAUs, and (3) disputes over a variety of organizational issues. The establishment of multiple universities is a key issue, because the Model Act specifies that only one university shall be established in each state. Nevertheless, many states have established multiple SAUs, and some states have created multiple campuses. The proliferation of multiple universities and campuses has spread already limited resources too thin, particularly in the poorer states. This is particularly problematic in the higher degree programs, for which specialized equipment and up-to-date library resources are essential. It has also created considerable diseconomies of scale in central university administration and use of facilities. This, in turn, has led to considerable deterioration in the quality of higher agricultural education and research in those states.

At many of the SAUs, debates continue over the value of the trimester system, disciplinary specialization, internal evaluations, and multiple examinations throughout the academic year. Discussions of these issues are usually framed in terms of the "U.S. system." Often, these debates appear to focus on conformity with an abstract U.S. model, rather than assessing the costs and benefits to Indian students of pursuing various approaches.

However, all of these debates raise the central issue of what purpose the SAUs should serve. When the SAUs were established, they had to respond immediately to the food needs of India. Hence, increasing agricultural production became and remains a central goal of the SAUs. Nevertheless, the very success of the SAUs in achieving this goal has created a new set of issues related to the role of the SAUs in meeting the future needs of India's agricultural and rural sectors.

Over the 25 years of the SAUs' existence, their achievements in agricultural education, research, and extension have been numerous. They have created one of the largest systems of agricultural universities in the world in less than 30 years and have developed the capacity to train students through the Ph.D. level. In addition, the SAUs, together with ICAR, have established the world's second largest agricultural scientific establishment, which includes numerous scientists who are international leaders in their respective fields. Finally, the SAUs have provided technical support to the various state extension services. In contrast to the situation 30 years ago, the state extension services can now draw on the considerable expertise developed within the SAUs. Few nations, if any, can attest to achieving so much within such a short time.

Among the factors contributing to these achievements of the SAUs are (1) the leadership and support provided by ICAR; (2) the support of the various state governments; (3) the demand for agriculture graduates; (4) the agrarian structure in the various states; (5) the support received from A.I.D., U.S. land-grant universities, and, more recently, the World Bank and the United Nations Development Program; (6) the continuity and commitment of the SAU leaders; (7) the pool of high-quality students; and (8) the openness of the SAUs to internal and external evaluation.

Because of their achievements, the SAUs have had considerable impact on agriculture and rural life in India. Even during the brief review team visits, many of these impacts became apparent. Among them are increased manpower for veterinary services; improved poultry and egg production; increased oppor opportunities for women -- even in agronomy and animal sciences; development of trained staff for government services; development of regional research stations in numerous agroclimatic zones, in part as a result of the National Agricultural Research project; use of artificial insemination to improve cattle breeding; major increases in milk production; animal feed improvement; massive increases in the production of wheat and rice, especially in irrigated areas; increases in selected areas of production of sorghum, millets, pulses, and minor crops; resolution of crop micronutrient shortages; greater use of biofertilizers and biological control methods; creation of farmer demand for extension through radio and television programs, bulletins written in local languages, and annual farmer fairs; and the creation of a cadre of skilled agricultural loan officers for the banks.

However, given the state of flux in world agriculture, agricultural educational institutions worldwide need to be able

to respond to a new and rapidly changing social, political, economic, cultural, ecological, and technological environment. The older purposes and objectives of such institutions are in question, calling not only for new purposes and missions, but for an examination of the very process by which missions are defined and implemented. The new worldwide challenge is to complement current orientations in agricultural production with an emphasis on productivity and sustainability as well as to move from a relatively stable to a constantly evolving mission. Restructuring agricultural universities worldwide to meet these new challenges requires not merely the addition of new departments, but also the incorporation of new ways of knowing and new kinds of knowledge. For example, a whole range of new theories of knowledge and its diffusion now exists, encompassing major changes in cognitive theory, the theory of research, and the philosophy of science. These new theories suggest that there are multiple ways by which knowledge can be created, each of which is relevant and appropriate under different circumstances. Moreover, thinking is shifting from a focus on the parts to a focus on the whole, wherein knowledge about how the parts fit together is given as much if not more weight than knowledge about the parts. Furthermore, to borrow a metaphor from biology, development is being reconceptualized as the co-evolution of people with their environments; that is, people and their institutions do not simply exist, but are constantly responding to changes in their social and natural environments. These changes, in turn, change the environment again in a continuing process of co-evolution and co-development.

To respond effectively to these new challenges, India's SAUs need to reexamine the strategies and structures they have used in the past. The first 25 years have been a period of establishment and of definition of the SAUs' structure, size, and external relations. Now, the problems faced by many of the SAUs, especially those established in the 1960s, are the problems of mature organizations. With this organizational maturity comes both the advantages enjoyed by having established procedures for entering new relationships and the disadvantages that result from organizational inertia. Specifically, a new group of issues has been identified by SAU faculty and others in India that will need to be addressed in the future. Among the issues discussed with the review teams were the following.

-- Management issues

- The SAUs will need to engage in more strategic planning and to build new constituencies.

- The universities are isolated from each other, from ICAR, and from the world scientific community.

- The SAU system is overly centralized given its scope and diversity.

- Faculty members are often uncertain about the mission of the SAUs.

- Faculty quality is often compromised by both the tendency toward in-state recruiting and the reward system.

- The SAUs lack a system of continuous review of programs, projects, and mission.

- In some states, state support is inadequate to meet the needs of the university.

- Information generated by the SAU system is often poorly disseminated across state boundaries through published reports and papers.

- Staff turnover among administrators is very high at some SAUs, leading to weak leadership.

- In some fields, the number of vacant faculty positions is exceedingly high.

-- Role of women. Women are inadequately represented in professional positions at all levels in the economy and in the student body at many universities. Given the importance of women's contributions to the Indian agricultural and rural economy, this is an issue of great consequence.

-- Curriculum and other disciplinary concerns

- The social sciences are understaffed at most SAUs,leading to an overemphasis on the technical side of agricultural and rural development issues.

- Extension education, while incorporating the latest technical advances in extension, is still premised on an outmoded model of communication by which all information flows to the farmer. Moreover, few studies of extension effectiveness or farmer needs have been undertaken.

- The basic sciences are limited in scope or nonexistent at many SAUs; because many existing technologies are now reaching their limits, the need for more basic science research has intensified.

- At many SAUs, the home science curriculum suffer from a lack of relevance to rural India.

-- Education. Teachers tend to favor lectures and rote memorization, perhaps as an attempt to compensate for the lack of textbooks and library resources. In addition, teaching loads are high, leaving students often easily frustrated. In many states, students are overwhelmingly from urban rather than rural areas and so are often unfamiliar with rural environments and

farming practices; in addition, students from urban areas are less likely to become actively involved in agricultural pursuits after graduation than are students from rural areas.

-- Research. Crop yields are leveling off after having risen steadily during the 1970s. At the same time, much of the equipment used for research at the SAUs is outdated or nonfunctional. Rather than taking an integrated, interdisciplinary approach to research, faculty are often at work on highly fragmented projects. Discipline-driven boundaries are particulary strong between the crop, animal, engineering, and social sciences.

-- Employment opportunities. Because the SAUs focus too closely on providing graduates for their respective state agricultural services, there is a lack of job opportunities for graduates.

In the context of the changes in world agriculture andthe issues currently facing India's SAUs, a number of future directions were identified in meetings with the review teams. First, the SAUs need to seek out new sources of funds beyond those currently supporting their activities. They need toredefine their role to include a greater focus on rural development. They need to develop new and innovative curricula (includinggreater emphasis on management skills) to respond to India's newneeds. The SAUs need to develop alternative employmentopportunities for graduates in the private sector, cooperatives, and inthe provision of new services to the rural sector.

Second, with respect to research, the SAUs need todevelop a systems orientation, to reevaluate indigenous knowledge, to improve dryland agriculture, and to use the new capabilities offered by computers. With respect to individualdisciplines, the SAUs need to introduce research on marketing into the changing Indian economy. They also need to restructure thehome science curriculum to make it relevant to the needs ofIndia's villages. The SAUs must increase their capabilities in the social sciences, including agricultural economics, rural sociology, agricultural business management, policy studies,and ethics. The SAUs also need to strengthen their foodtechnology and basic science programs so that they can effectivelyaddress the new issues of future decades.

Third, progress in the interdisciplinary area ofenvironmental and resource management requires research and education in areas such as water management, soil conservation, pesticide pollution, and agroforestry. With respect to agricultural extension, the entire role of extension needs to berethought, and new systems for communicating more complex forms ofknowledge both to and from farmers need to be established.

To conclude, there are at least three ways to thinkabout organizations. The most common way is to think of them asbeing self-contained, having little contact with and being little influenced by their external environment. The second way isto think of organizations as responding to a continuing arrayof pressures and requests from an external environment that maybe friendly or hostile. The third way is to think of them asactive shapers of their own environment. The challenge facing the SAUs -- and most agricultural universities around the world, including those in the United States -- is to move frommodel one or two to model three over the next decade.

Perhaps the key element needed to effect such evolutionis the political support of the Government of India -- suchsupport will permit the SAUs to develop into proactive, environmentshaping organizations. Without that clearlydemonstrated political support and commitment, it is unlikely that the universities themselves could accomplish much. Positive evidence of the importance of such support and commitment is found inthe Government's initial decision to found the SAUs in the1950s.

Also of importance to the organizational evolution ofthe SAUs is the formation of linkages between an individual SAU and other agricultural organizations in its immediate area. In addition, the SAUs need to institutionalize a process of strategic planning to ensure that their respective missionand supporting programs remain responsive and relevant tochanging conditions within the Indian economy. Finally, the States' extension services should be used to feed information intothe respective SAUs. By this is not meant feedback on adoptionof innovations by farmers, but translation of farmers' needsinto topics that can be researched.

In short, the SAUs have accomplished much in the short period of their existence. Their very success has created anew range of problems that were only vaguely foreseen at their inception. The challenge for the next century is todetermine new directions for the SAUs. To what degree should the SAUs emphasize production or productivity? Immediate needs or long-term sustainability? Disciplinary or interdisciplinary research? A commodity focus or a systems focus? Reactive organizations or proactive ones? Hierarchical organizationsor participatory ones? To what degree should the SAUs beagricultural universities or universities for rural development? Given their record, we are confident that the SAUs have withinthem the people who can make these complex and difficult decisionsand effect changes of such great magnitude.

GLOSSARY

A.I.D. - U.S. Agency for International Development

APAU - Andhra Pradesh Agricultural University

AUC - Agricultural Universities Committee

CDIE - Center for Development Information and Evaluation, A.I.D.

FAO - Food and Agriculture Organization of the United Nations

GBPAU - G.B. Pant Agricultural University

HAU - Haryana Agricultural University

IARI - Indian Agricultural Research Institute

ICAR - Indian Council for Agricultural Research

JNKVV - Jawaharlal Nehru Krishi Vishwa Vidyalaya

MPKV - Mahatma Phule Krishi Vidyapeeth Agricultural University

MSU - Mohanlal Sukhadia University

NAARM - National Academy for Agricultural Research Management

OUAT - Orissa University of Agriculture and Technology

RAU - Rajendra Agricultural University

Rs - rupees, India's currency

SAU - state agricultural university

TNAU - Tamil Nadu Agricultural University

UAS - University of Agricultural Sciences

UEC - University Education Commission

UNDP - United Nations Development Program

> However much we in India may progress in the domains of science and industry, as undoubtedly we will, the basic fact remains that agriculture is of primary significance to our country and to the world.
>
> Jawaharlal Nehru, 1959

1. INTRODUCTION

India has achieved remarkable progress in the 40 years since it became an independent nation. Much of this progress is

attributable to the role of the state agricultural university (SAU) system, a system that was initiated only in 1960. Indeed, not too long ago it was common to hear that India was on the verge of mass starvation, that it was in hopeless economic stagnation, and that it would always be bound by ancient traditions that had no relevance to the present or future.

Today, few persons of any political persuasion would make such statements. Although India has by no means resolved all of its problems, it has been able to make extraordinary progress in a very short time. Its agriculture is now capable of sustaining its entire population, and widespread famine is no longer a threat. India has begun to show the world that its traditions and institutions are both viable and adaptable to the changing conditions of the modern world.

This impact evaluation comes as the SAU system is about a quarter century old, young by any standards and certainly by those of Indian history. Yet, there is little doubt that these institutions have accomplished much more in the first 25 years of their existence than the American agricultural universities accomplished in the first 50 years of their's. This is not due to any special aid received from the United States or elsewhere but to the national leadership and the perseverance and dedication of thousands of Indian educators and scientists.

Nevertheless, there is reason for concern. The rural sector in India has not been receiving its fair share of national income. Recent figures suggest that rural incomes are now considerably lower than urban incomes and continuing to decline. Nor have income disparities been significantly reduced. In addition, the Indian Council for Agricultural Research's (ICAR) proportion of the total public research and development budget has declined from 20 percent in 1950 to 12 percent in 1987. Moreover, during that period ICAR was given the responsibility of supporting research at the SAUs (The Hindu October 13, 1987).

To these problems specific to India must be added issues of a more global nature. The next quarter century of agricultural research and education will be quite different from the last in all nations of the world. No longer is the worldwide issue in agricultural research that alone of increasing production. Indeed, in the Western nations the problem is one of how to reduce overproduction. In India, the need for increased production is complemented by other needs of equal importance: improving and diversifying diets; developing new foods and processing technologies; building an increasingly diverse agriculture in which milk, poultry, fruit, and vegetable production play an ever larger role; and ensuring that rural areas develop apace with urban ones in the generation of employment and income. All nations need to be concerned about soil erosion, deforestation, and other forms of environmental degradation and pollution. Resolution of these issues will require changes in agricultural research and education and in the methods used to deliver agricultural extension services. Moreover, the course for the next quarter century has not yet

been charted by any nation.

It is within this context of a changing world agriculture that we have conducted this study. Hence, unlike many of the evaluations of the 1960s and 1970s (see, for example, ICAR 1955; 1960; and 1978), our focus has not been primarily on the technical problems facing scientists in the SAU system. Nor has it been on the details of course requirements, examination systems, or degree requirements. It is not that we see these issues as unimportant, but that we firmly believe that they are eclipsed by issues of greater magnitude.

In particular, in the spirit of the report of the University Education Commission (UEC) (1962) prepared in 1948-1949, we believe that the questions embraced by the concept of mission or purpose are of central concern. However, we have attempted to go beyond the commission's report in asking how the very process of examining purposes and missions in light of an ever-changing socioeconomic and technological environment might itself become an integral part of agricultural universities worldwide.

Thus, in our interviews in India with SAU faculty and administrators, state officials, and farmers, we focused on the purposes served by the people, departments, colleges, universities, ICAR, the SAU system as a whole, and the Government agencies. We also tried to identify the strategic planning mechanisms that were used to define and redefine the SAUs' purposes, missions, and goals, in light of the changing conditions and demands facing them. Moreover, we examined the processes used to evaluate the progress of SAUs in achieving the stated purposes and objectives at various levels. Finally, since all institutions must operate within an environment in which there are various sorts of constraints, we attempted to identify these as well.

Although everything we note may not be apparent to all participants in the SAU system, there is little in this report that will be new to those familiar with the SAUs. Therefore, the report should be seen as a vehicle for debate about purposes and missions of the SAUs, including their potential for serving as mechanisms for change, and not as a set of discrete recommendations. (Indeed, given the novelty of the problems currently faced by world agriculture, and the participative character of the strategic planning process, it would be presumptuous to make detailed recommendations about a system we have only examined briefly.) The report focuses on the SAU system as a whole, although it is of necessity written in terms of specific issues. Attempts to address any or all of the specific issues without setting them in a systemic context are unlikely to be successful.

Section 2 of this report delineates the purpose and objectives of this study and briefly examines the methods used in conducting the study of India's SAUs. Sections 3-7 provide a review of the development of the SAUs from their conception in 1949 to the present. Sections 9-11 look to the future, focusing first on the

changing context of both Indian and world agriculture, then on problems, issues, and opportunities facing India's SAUs, and finally on future directions of the SAUs. Sections 3-10 emphasize the purposes of the SAU system, its strategic planning and evaluation mechanisms, and constraints facing the system at various levels. Section 12, the conclusion, offers some thoughts on building an environment conducive to agricultural universities by working to eliminate some of the constraints.

The members of the five review teams gathered for this study have benefited greatly from the insights of hundreds of scientists, extension staff, administrators, students, farmers, government leaders, and others. These insights assure us that as we look toward the next quarter century of agricultural education and research around the world, India's SAUs will be seen as full partners in developing the future.

2. PURPOSE OF THE STUDY AND METHODOLOGY

2.1 Purpose and Objectives of the Study

This study of India's state agricultural universities (SAUs) was undertaken to provide information that would be of use in undertaking the following activities:

-- Documenting the achievements of the SAUs in the improvement of Indian agriculture

-- Improving agricultural university systems worldwide

-- Developing future donor activities to enhance the effectiveness of all agricultural universities

In addition, the study had three specific objectives:

-- To evaluate the impact of the SAUs on Indian agriculture tas part of a larger A.I.D. Center for Development Information and Evaluation (CDIE) study of the impacts of agricultural universities on agriculture in developing countries

-- To evaluate the U.S. role in support of the development of the Indian SAU system

-- To provide a basis for future U.S. relationships with the Indian SAUs

2.2 Methodology

Any study of this scope must necessarily be a compromise between the needs of the sponsoring agencies and the funds available for the purposes at hand. In this case, it was necessary to develop a procedure that would permit both the analyses of the impacts of particular SAUs -- each of which have

their own history and special characteristics -- as well as the development of an overview of the entire SAU system. To accomplish both tasks, the evaluation team sent a survey to each SAU, requesting certain basic information, and sent review teams to 10 selected SAUs to conduct a more careful examination of local conditions through interviews with faculty and staff.

2.2.1 The Universe of Institutions Included in the Study

For some of the study's objectives, it was possible to gather information on all the SAUs through a survey that requested budgetary and other quantitative information about each SAU. However, to satisfy other objectives requiring more in-depth information, the evaluation team needed to select a representative sample of SAUs from which to work.

Given the enormous complexity and size of India's SAU system, some sort of sampling frame had to be devised. Because the unit of analysis for this study is the university, the following criteria were used in choosing universities to study in depth:

-- Several of the eight universities receiving significant A.I.D. funding should be represented

-- Several universities that received no A.I.D. funding should be included as a control group

-- Several different agroclimatic zones and cropping areas should be represented

-- Universities founded too recently to have had any significant impact were excluded from the analysis

Based on these criteria, the following 10 SAUs were chosen for in-depth study:

-- G.B. Pant University of Agriculture and Technology (Uttar Pradesh)
-- Andhra Pradesh Agricultural University
-- Haryana Agricultural University
-- Tamil Nadu Agricultural University
-- Orissa University of Agriculture and Technology
-- University of Agricultural Sciences (Karnataka)
-- Mohanlal Sukhadia University (Rajasthan)
-- Rajendra Agricultural University (Bihar)
-- Jawaharlal Nehru Krishi Vishwa Vidyalaya (Madhya Pradesh)
-- Mahatma Phule Krishi Vidyapeeth (Maharashtra)

2.2.2 Meeting With University Vice-Chancellors and Conducting On-Site Interviews

After developing the general outlines of the study with Dr.

Maharaj Singh of the Indian Council for Agricultural Research (ICAR), Drs. Hansen, Pollock, and Busch met with the vice-chancellors of the SAUs in New Delhi on February 12, 1987. At that meeting, Dr. Ralph Cummings, Sr. gave an overview of the development of India's SAU system from his perspective as one of the key American participants in its development. The purpose and objectives of the study were then explained to the vice-chancellors and received their enthusiastic support.

Over a period of about 8 months, five review teams of five to eight persons each visited two of the universities selected for this study. The teams comprised scientists and administrators representing a wide range of disciplines and backgrounds. Although most of the team members were from the United States, teams also included members from Australia and one from the United Kingdom. The teams spent about 10 days at each university interviewing numerous university administrators, faculty members, students, and representatives of the various client groups with whom the universities work.

After spending 10 days in the field, each review team returned to New Delhi and spent 3 to 4 days writing a first draft of their team report according to the outline presented in the study's implementation plan. Each report was then refined under the supervision of the Team Leader. The final team report for each university became the basis for the synthesis presented here.

3. HISTORICAL DEVELOPMENT OF INDIA'S AGRICULTURE

Indian agriculture is among the most diverse in the world. In some areas it is characterized by nomadic herders who move their animals over long distances and subsist on animal products. At the other end of the spectrum are highly mechanized, monocultural grain farms that in many ways resemble those of the Midwest United States. In between these extremes are innumerable agricultural systems, ranging from subsistence smallholder production to market and semimarket oriented production of a wide variety of grains, fruits, vegetables, nuts, animals and animal products, fish, timber, and fiber.

The rich diversity of agriculture in India reflects the wide range of ecological, social, cultural, economic, and political relations and patterns found throughout the nation. These conditions cannot be captured in one simple summary, but a brief overview of the history of Indian agriculture is essential to understanding the problems that agriculture and the state agricultural universities (SAUs) face today. (For a more detailed review of Indian agriculture and agricultural education and research, see Deo 1987.)

3.1 The Colonial Period

During the long period of British rule, two systems of land tenure were introduced or strengthened in accordance with British interests in ensuring their continued dominance of India and a

steady supply of money for the Government's treasury. Under the zamindari system, a class of large landowners was created. They enjoyed both feudal privileges and rights of ownership based on western precepts of property law. It was expected that these Indian landowners would invest in agriculture as did the British aristocracy; instead, they tended to sell their right to cultivate to the highest bidder, creating a large class of tenants and sharecroppers as well as much business for moneylenders. However, these landowners did form a group with substantial loyalty to and support for British rule.

In contrast, under the ryotwari system, occupancy but not ownership rights were granted by the Government and revenue was collected directly from the peasants. By collecting taxes directly from the peasants, the Government also created a demand for moneylending.

During the period of British rule, little attention was paid to foodgrains (other than wheat to supply the export market). In fact, foodgrain yields declined 0.18 percent per year from 1891 to 1947, while yield of non-foodgrains increased by 0.88 percent annually during the same period and by 1.15 percent per annum during the latter half of the period (Pray 1984). Departments of agriculture were established in each of the provinces, following the recommendations of the Famine Commission of 1880. These departments were designed to collect statistical information about the provinces rather than to do scientific work. In 1905, the first agricultural research institute was established at Pusa in what is now Bihar. The Imperial (now Indian) Agricultural Research Institute (IARI) was to serve as the center of a far-flung network of research stations throughout the empire. At about the same time, a number of agricultural colleges were founded in each province, each offering 3-year agriculture degrees. Many of these colleges were later incorporated into the SAU system.

Nevertheless, agricultural research was slow to develop. Therefore, in 1926, the Royal Commission recommended the development of the Imperial (now Indian) Council of Agricultural Research (ICAR) as a coordinating body. The council was established in 1929, but initially it had no control over Imperial or provincial research institutions. Moreover, the focus of Indian agriculture remained largely on producing cash crops for export. The agricultural and veterinary colleges, in contrast, remained teaching institutions under provincial control. Agricultural extension remained essentially nonexistent. In 1934 an earthquake destroyed the IARI building at Pusa and the institute was moved to Delhi.

With the outbreak of World War II, the British Government launched a "Grow More Food" campaign. Its objectives included the expansion of the area under foodgrain cultivation and increased use of improved seeds, fertilizers, and irrigation. However, the campaign was limited to about 4 percent of the total cultivated area of India.

3.2 The Period of Independence

Questions about agrarian relations including land reform were raised by nationalist leaders early in the struggle for independence. At the time of independence, Indian agriculture was characterized by a highly skewed distribution of land ownership, large numbers of landless or near-landless peasants, and a near-feudal landlord class. The wealthier peasants often produced for the market while the poorer ones remained subsistence producers. All were indebted to agricultural moneylenders, who supplied 75 percent of total credit.

By 1948, India had 17 agricultural colleges. However, only 160 students could be accommodated at the postgraduate level. At the same time, research and extension languished. Moreover, much of it was highly theoretical and far removed from the needs of India's farmers.

The weak system of higher education in India did not go unnoticed after independence. In 1949, the University Education Commission (UEC) was established in an effort to identify and rectify the problems of higher education in India. Seven Indians, two Americans, and one Englishman were appointed to the UEC, which expressed its concern over the inadequate numbers of faculty and researchers, the overall quality of teaching and research, and the lack of social relevance found in India's higher education. In addition, the commission was concerned about the lack of autonomy given to the universities.

The UEC specifically addressed the lack of higher education in rural areas, calling for the creation of a system of "new rural colleges and universities, with freedom to create a distinctive tradition as to purposes, spirit, and methods" (quoted in Read 1974, 4). These universities were to have a common core of liberal education and a curriculum tailored to the needs of individual students. Indeed, "no field of human concern should be foreign to the rural university" (UEC 1962, 576). In addition, they were to be autonomous with respect to decisions about curriculum and examinations. The UEC considered the U.S. landgrant university system as a possible model for the new institutions.

Although U.S. citizens were called on to participate in this endeavor, it should be emphasized that it was an Indian initiative. Soon after, as part of the original Point Four Program, the United States offered to assist India in the development of a system of agricultural universities. "The Agricultural University concept was based on the need for a project in which research, teaching and extension would be fully integrated and geared towards solving the felt needs of the farmer" (ICAR, 1979, 9).

3.3 The 1950s

Until 1958/1959, India had sufficient food to meet effective demand -- largely as a result of the favorable weather of the

decade and the considerable imports provided under U.S. Public Law 480. Although the zamindari system was abolished during the 1950s, the state-by-state legislative response to land reform produced uneven results. The landlord system was abolished, but large variations in the size of landholdings remained in many states. In addition, crop failures in 1958/1959 once again brought the issue of food production to the fore.

In 1952, the "Grow More Food" campaign became the basis for the new Community Development Program, a program that emphasized village self-help. The program encouraged the creation of cooperatives as a solution to the disadvantage of small landholdings. The program also emphasized both increasing agricultural production and resolving the problems of the villages. The key person in the Community Development Program was the gram sevak, or village-level worker, through whom all information to improve the village was to flow. Although the program received heavy support from the Ford Foundation and USAID/India from its inception through 1961, by the late 1960s it had little to show for its efforts, with Indian village social structure having remained largely untouched by the program.

The 1950s also brought the first linkages between India and the U.S. land-grant universities. In 1952, Arthur Mosher, who was then serving as Principal of the Allahabad Agricultural Institute, arranged for the University of Illinois to help develop that institute with a small grant from the predecessor of A.I.D. The land-grant universities of Illinois, Ohio State, Missouri, Kansas State, and Tennessee entered into a technical assistance agreement with India in 1955, dividing India into five regions for operational convenience. Forty agricultural and veterinary colleges as well as two research institutes were to be helped. However, confusion abounded as neither Americans nor Indians were quite sure what their roles were in this assistance. Moreover, a handful of American advisers, often recruited solely for that purpose, were spread thinly over the Indian landscape.

In 1955, a joint Indo-American team (ICAR 1955) was asked to examine the entire field of agricultural higher education and research in India and to recommend improvements. An Indian delegation spent 3 months in the United States examining landgrant universities while an American team of three examined the situation of agricultural higher education in India. The joint team urged that agricultural universities similar to those in the United States be established and that these institutions not offer postgraduate education unless their faculty conducted research. The team also recommended close ties between colleges of agriculture and technology (i.e., engineering) in each of the universities.

India's declining food production in the late 1950s led to the formation of the Agricultural Administration (or Nalagarh) Committee, which was charged with streamlining administrative and financial procedures in agricultural organizations. The committee argued that agricultural research was inadequate to meet India's agricultural needs and that education for cultivators was needed.

It also recommended integration of all agricultural functions under a single ministry at the state level. Finally, the committee stated that village-level workers were to concentrate on agricultural production until agicultural technicians were available.

In 1959, an Agricultural Production Team was created. It urged that the food problem be recognized as an emergency and that agriculture be made a top priority. Price incentives were to be used to ensure that production goals were met. In that same year a second Indo-American team (ICAR 1960) was formed. It was asked to evaluate progress made since the first team report and to review the relations with the U.S. land-grant universities. The team urged that the process of university development be expedited and that one agricultural university similar to a U.S. land-grant university be established in each state. All agricultural research was to be coordinated by ICAR. The Community Development Program's broad focus was to be narrowed and the program was to be ceded to the Ministry of Agriculture, a point that was the subject of some dispute among the Indian members of the joint team (ICAR 1960, 72-74).

3.4 The 1960s

In 1960, the Government of India established the Agricultural Universities Committee under the leadership of Dr. Ralph W. Cummings, Sr., who at the time was also the director of the Rockefeller Foundation Indian Agricultural Research Program. (Rockefeller Foundation support of linkages between U.S. landgrant universities and Indian agricultural institutions was of particular importance from the late 1950s onwards. See Streeter 1969; Lele and Goldsmith 1986.) Committee members visited the various states upon request of their respective governments.

During such visits, commitee members reviewed proposed legislation and implementation plans for institutes of agricultural higher education to ensure that they met certain criteria, including the integration of teaching, research, and extension, an applied orientation, and responsiveness to the needs of the state's residents. Only those states approved for funding by the Agricultural Universities Committee received Indian Government and A.I.D. financing. From this time on, all USAID financing for institutions of higher agricultural education was to be limited to those states with established agricultural universities. This was in part a response to pressure from A.I.D.-Washington to show that clearly demonstrable impacts were being felt. This represented a refinement of the earlier thinking of the UEC, which had suggested the land-grant philosophy (as opposed to its form) be considered for adoption by India.

The report of the Agricultural Universities Committee became the basis on which ICAR developed the Model Act, which was designed to guide state legislation concerning the creation of agricultural universities. First made available to the states in 1966, the Model Act enumerated the following four goals for the SAUs (ICAR 1981, 6):

1. To impart education in different branches of study, particularly agriculture, horticulture, veterinary and animal sciences, fisheries, forestry, agricultural engineering, home science, and other allied branches of learning and scholarship

2. To advance learning and research, particularly in agriculture and other allied sciences

3. To extend knowledge gleaned from such sciences, especially to the rural people of the state

4. To achieve such other purposes as the university may from time to time determine

From 1952 and 1972, the six land-grant universities of Illinois, Kansas, Missouri, Ohio, Pennsylvania, and Tennessee entered into agreements to assist the Government of India in developing nine agricultural universities in India at a total cost of approximately $31 million in U.S. dollars and $11 million in U.S.-owned rupees. In addition, smaller sums were paid to support particular projects at other SAUs. During the 20 years of U.S.-Indo cooperation, 337 U.S. faculty members were assigned to posts in India and more than 1,000 Indians received M.Sc. and/or Ph.D. degrees from these six U.S. universities. This number does not include significant numbers of Indians who were supported through various fellowship programs or through their own funds and who received U.S. university degrees at both cooperating or other land-grant institutions. Nor does it include the many Indians trained at home at public and private agricultural colleges whose primary mission was and remains teaching. These Indian institutions, although outside the scope of this study, still play a significant role in training undergraduate agricultural students (see Table 1 for details). In short, the 20-year period of intensive assistance to the SAUs can be described as the single largest agricultural education project ever undertaken by A.I.D.

Both A.I.D. and ICAR began this effort with "the complete concept of what such an institution [an SAU] should be and ... aimed from the very beginning at giving fairly full visible shape to this concept" (Stevenson and Mehta 1960). This sense of purpose is in sharp contrast to the restricted role served by the first U.S. land-grant universities, which began as colleges of "agriculture and the mechanic arts" in 1862. These institutions had no research functions until the passage of the Hatch Act in 1887 and no extension responsibilities until the passage of the Smith-Lever Act in 1912. In addition, they remained largely agricultural institutions (with a few exceptions) until well after the end of World War II. Only in the early 1960s did the U.S. land-grant universities embark on large-scale expansion programs that boosted overall enrollments and increased the range of programs offered far beyond the confines of the original agricultural colleges.

Thus, the U.S. land-grant universities of the 1960s were still

strongly agricultural in their orientation and very conscious of their agricultural mission. In short, unlike the land-grant system in the United States, which developed over 125 years into a system that came to embrace research and extension as well as teaching, India's SAU system sprang up virtually overnight as a full-fledged, comprehensive system. The SAU system was based on a well-defined model that had been developed through trial and error and that could be adopted in its entirety and then tailored to the Indian context.

Nevertheless, the change from the British-oriented system to the U.S. system was abrupt and not without difficulties because many administrators, faculty members, and students were unclear about the goals of the new system. Also, "the fact that a positive procedural program was not well laid out in advance has been most discouraging to many of the people who had to work with the program" (Hannah 1956, 9). Political leaders as well were often resistant if not hostile to the new system (Read 1974). On the

Table 1. Educational Fields, Degree Programs, Admission Capacities, and Number of Colleges in the Indian State Agricultural University System, 1986

Educational Fields	Number of Universities Offering Degree Programs			Colleges in SAUsa	Admis. Cap. Under Post grad	Admis. Cap. Post grad
	B.Sc.	M.Sc.	Ph.D.			
Agriculture	23	22	19	44	5490	2506b (92)c(9400)d
Veterinary	19	19	16	22	1600	450
Agricultural Engineering	10	6	3	10	530 (12)	200 (570)
Home Science	13	8	5	13	670	115
Dairy Science	7	13	2	7	180 (9)	200 (200)
Fisheries	5	2	1	5	150	55
Forestry	1	1	1	1	50	12
Food Science	1	1	1	50		6
Horticulture	3	21	12	3	80	
Marketing /Banking Cooperatives	2				80	
Sericulture	1	1			30	

{a} Number of colleges in state agricultural universities only.

{b} Including horticulture.

{c} Numbers in parentheses for this column indicate total number of agricultural colleges in the country, including those outside the SAU system. Lack of a number in parentheses indicates that all colleges are in the SAU system.

{d} Numbers in parentheses for this column indicate total admission capacity in the country as a whole.

Source: Data furnished by the Indian Council of Agricultural Research.

other hand, there were a substantial number of Indians,including many if not most who studied at U.S. land-grantuniversities, who were ardent advocates of the new approach.

The 1963-1968 period witnessed rapid increases in foodgrain imports as a result of India's extremely severe drought. Food shortages began, and prices of both food and nonfood items rose considerably. This situation eventually led to what later became known as the Green Revolution. By 1965, the Ministry of Food and Agriculture had developed a new agricultural strategy that combined high-yielding seed varieties with a "package" of complementary inputs, including an ensured water supply. This strategy represented a significant move away from the earlier national policy of community development; under this new approach, inputs were to be concentrated in the areas with the highest potential for increased productivity. This marked a clear Government decision to set aside, at leasttemporarily, issues such as equity and rural development in the face ofthe immediate need to markedly increase food production. Emphasis at the SAUs was to be on applied, adaptive research with morebasic studies postponed until later.

In 1968, wheat production increased by 5-million tons and overall foodgrain production increased by 28 percent over the base period of the drought years of the mid-1960s. However, agrarian unrest began to mount, leading India's Home Ministry to issue a report in late 1969 on "The Causes and Nature of the Current Agrarian Tensions." The report explicitly linked issues of land tenure, the Green Revolution, and agrarian tensions,as follows:

> The land reform measures have not benefited the actual tiller in all cases.... Much of the land is cultivated in small landholding by tenants and sharecroppers who lack security of tenure and who have to pay exorbitant rents. Inequalities in landholdings have persisted because of the failure to implement ceiling laws. As for the sharecropper and landless

laborers, they have been more often than not left out in the cold (quoted in Desai 1986, 40).

3.5 The 1970s

The 1970/1971 crop year produced a bumper harvest for India. However, there was still uncertainty about thepermanency of the higher yields. At the same time, supporters of the Green Revolution often portrayed the movement in whollypositive terms, while its critics, especially social scientists, tookan extremely pessimistic view of its effects on landdistribution and inequality in the countryside.

In 1972 as a result of political tensions between the United States and India, the U.S. teams were asked to leave India. This decision was met with regret by both Indian and U.S.scientists. The sharp break adversely affected the SAU system by slowing its growth and development.

The internal emergency declared in 1975 was soonfollowed by Government pledges to implement agricultural land ceilings and otherwise improve the situation for the rural poor. That year (1975/1976) was the best ever in terms of crop yield, yet the Indian economy had entered a period of stagnation.

In August 1970, the Government appointed a National Commission on Agriculture. This commission published a comprehensive report in 15 volumes, one of which was specifically devoted to agricultural research, education, and extension. Among the commission's recommendations were that more attention be devoted to fundamental research, that only one SAU be established in each state, and that better linkages be established between research and agricultural extension.

In 1977, ICAR undertook an internal review of the SAUs(ICAR 1978). The extraordinarily thorough report that resulted from this review recommended that all research facilities betransferred from the state governments to the SAUs; that the functions of teaching, research, and extension be better integrated;that each state have only one agricultural university; that high standards be maintained in the appointment ofvice-chancellors; and that new programs be established only when the requisite faculty and facilities were in place. The ICAR report alsourged that practical training programs be instituted for all undergraduates, that more emphasis be given to training for selfemployment, that home science be made more rural in its orientation, and that faculty selection be made bycommittees with larger numbers of outside experts. We concur with many if not most of the recommendations set forth in the ICAR report.

3.6 The 1980s

Recent figures on crop yields are presented in Table 2,which shows that overall yields for many major crops have increased significantly during this decade. However, increases in wheat and rice yields accounted for much of the overall yield increase.

Sorghum yields have changed little since the late 1970s. Milletyields grew considerably in 1983-1984, but it is not clear if thatrepresents a change in the trend of this crop's yield. Chickpea andcowpea yields have shown only annual fluctuations in yield. Oilseed yields have gone up, as have potato yields. Moreover, these dataconceal substantial variations by state in crop yields. Even riceand wheat yields in some states lag far behind the national average.

Table 2. Yield per Hectare of Major Crops in India, 1970/1971 to 1983/1984(Kilograms per hectare)

Group /Commodity	'70 '71	'75 '76	'77 '78	'78 '79	'79 '80	'80 '81	'81 '82	'82 '83	'83 '84{a}
Kharif Food Grains	837	889	938	942	783	933	946	884	1063
Rabi Food Grains	942	1047	1091	1166	1046	1195	1193	1296	1342
Total Food Grains	872	944	991	1022	876	1023	1032	1035	1163
Kharif Cereals	892	957	1010	1020	848	1015	1021	956	1151
Rabi Cereals	1093	1236	1311	1396	1276	1434	1469	1552	1614
Total Cereals	949	1041	1100	1136	982	1142	1157	1151	1299
Kharif Pulses	410	418	420	389	329	361	415	402	476
Rabi Pulses	607	621	577	610	432	571	536	615	597
Total Pulses	524	533	510	515	385	473	483	519	541
Kharif Rice	1000	1195	1274	1284	1024	1303	1266	1185	1416
Rabi Rice	1625	1964	1995	2151	2116	2071	2204	2135	2223
Total Rice	1123	1235	1308	1328	1074	1336	1308	1231	1458
Wheat	1307	1410	1480	1568	1436	1630	1691	1816	1851
Kharif Sorghum	533	685	855	792	763	737	837	760	853
Rabi Sorghum	354	427	536	572	599	520	538	501	540
Total Sorghum	466	591	739	708	699	660	727	657	734
Maize	1279	1203	1051	1076	979	1159	1162	1145	1346

Millet	622	496	426	489	373	458	470	469	646
Chickpea	663	707	678	745	481	657	590	715	651
Cowpea	709	786	735	716	643	689	745	680	769
Kharif Groundnut	N.A.	902	809	773	738	629	866	604	838
Rabi Groundnut	N.A.	1422	1485	1437	1363	1444	1613	1516	1544
Total Groundnut	834	935	866	835	805	735	972	732	953
Rapeseed and Mustard	594	580	460	525	411	560	541	577	659
Kharif Oilseeds	649	695	625	609	552	492	644	511	663
Rabi Oilseeds	449	522	471	513	459	588	621	639	718
Total Oilseeds{b	579	627	563	570	516	532	634	563	685
Sugarcane	48322	40903	56160	49114	49354	57844	58359	56441	55904
Cotton	106	138	157	167	160	152	166	163	144
Jute and Mesta	1033	1163	1108	1186	1177	1129	1310	1265	1297
Jute	1186	1367	1210	1317	1310	1245	1480	1458	1470
Mesta	684	805	883	882	888	828	881	771	850
Potato	9976	11738	12228	12555	12152	13256	12996	13549	15206

{a} Final estimates.

{b} Include groundnuts, rapeseed and mustard seed, sesame, linseed,castorseed, nigerseed, sunflower seed, safflower seed, and soybean.

Source: Government of India (1985, 97).

These figures suggest that India has had only limited success in maintaining the high rates of annual growth in productivity that marked the Green Revolution. This is cause for concern.

4. Overview of the State Agricultural Universities System

4.1 Purpose and National-Level Coordination

Although the Indian State agricultural universities (SAUs) were in some ways patterned after those in the United States, they have been modified to meet Indian needs and preferences.

Today there are 26 SAUs (several states have more than one). (In addition, the Indian Agricultural Research Institute [IARI] and the Indian Veterinary Research Institute award postgraduate degrees, but they were not examined for this study.) Each SAU, which is a state institution, receives funds from the respective state, the central Government, and other sources (e.g., grants, contracts, and proceeds from foundation seed and farm product sales). At some SAUs local sources of funds appear to constitute a considerable portion of the total university budget. Interviews with key informants suggest that the Indian Council for Agricultural Research (ICAR) funds generally average about 25 percent of the typical SAU budget, with great variation by state.

The SAUs are charged with carrying out research within the state on problems of local agricultural significance. In addition, they provide undergraduate and some graduate training in various agricultural and related disciplines. Because each university is responsible to its respective state, there are significant differences in the range of teaching and research programs offered. In general, however, Indian SAUs do notoffer degrees in nonagricultural disciplines as do U.S. land-grant universities. The exception is found in the state of Rajasthan, where a general university includes an "agricultural wing." However, a separate agricultural university has recently been established in that state as well.

In addition, each SAU is responsible for agricultural extension education in its state. In practice, this usually means that the SAU provides state agricultural specialists who reside at the main campus or at branch stations. These state specialists, along with SAU faculty, provide regular training sessions for state extension agents. These agents, however,are not employees of the university but of the state-level departments of agriculture. Each state department of agriculture has a director who is responsible for various agricultural programs, including coordination with university-based research programs. Moreover, a national-level commissioner of agriculture provides technical support and program evaluation to the states.

At the national level, the university system is coordinated, although not directed, by ICAR. ICAR is responsible for financial support of some scientists at the various SAUs as well as staff support (provided through advice, consultation, and inservice training) for all university faculty. Inaddition, ICAR has its own research laboratories, the IARI laboratories and other National Research Institutes, which were established to focus on agricultural problems of national scope. These institutes also serve as research laboratories for graduate students at the various SAUs. ICAR scientists, in turn, often sit on these students' examination committees. IARI-Delhi and the Indian Veterinary Research Institute at Izatnagar (Uttar Pradesh) offer their own graduate degrees. In addition, the National Dairy Research Institute at Karnal and theFisheries Institute at Bombay have applied for this status.

ICAR also directs and coordinates the various "All-India" research projects. These projects are initiated by ICAR and carried out jointly by ICAR and the staff at one or more of the SAUs.

Through the recently established National Academy for Agricultural Research Management (NAARM), ICAR studies andattempts to improve the management of the SAUs and its own research stations. NAARM works in six areas: (1) agriculturalresearch systems and policies, (2) educational systems technologies, (3) transfer technology systems and policies, (4) project management, (5) human resources development, and (6)information and documentation. NAARM conducts workshops, seminars, andother activities designed to enhance the effectiveness of theentire agricultural research, teaching, and extension system. Italso maintains a library of considerable scope on agricultural research management. Finally, NAARM publishes a quarterly journal, Agricultural Research Management Abstracts, whichis probably the only such journal in the world and promises tofill a void in this area. NAARM has the potential of becoming a significant and effective addition to the Indianagricultural research system and may eventually provide support forresearch institution building in other countries as well.

4.2 Internal Structure

The internal structure of each SAU differs slightly from state to state, although the general organization is similar everywhere. Each university is directed by a board of management. A chancellor, who is also the governor of the state, is the nominal head of the SAU. The vice-chancellor reports tothe board and handles the daily operations of the university. Each university has several colleges, the deans of which report to the vice-chancellor. In addition, there are deans who administer programs in university teaching, research, and extension education, respectively. A registrar is in charge of student affairs and records, and a comptroller, usually a state employee, maintains the university financial records.

In the areas of agricultural research and extension, the research program thrusts are informed by the research and extension advisory councils, respectively. At most SAUs,the vice-chancellors chair these councils.

Although teaching and extension education funds are received largely from the individual states, research funds are received from both the state governments and ICAR. In practice, some scientists are fully supported by the state, some by ICAR,and some by both entities.

At many SAUs, each department is headed by a single professor, leading to a multiplicity (at least by comparison with U.S. norms) of departments. Moreover, teaching loads tendto be inversely related to rank: full professors tend to have the smallest loads, while assistant professors have the heaviest

ones.

Currently, there are 44 colleges of agriculture and 22 of veterinary science within the SAU system (Table 1). This group of colleges provides more than half the national admission capacity in agricultural education programs at theundergraduate level. At the postgraduate level, a majority of studentsattend SAU constituent colleges. Total enrollments in agricultural education programs peaked in 1965-1966, when some 90 colleges of agriculture enrolled 11,562 students (Gautam 1981). Since then, although the number of such colleges has increased slightly, enrollments have declined to the current level of 9,400.

At present, there are 28,000 scientist posts at the SAUs and National Research Institutes, of which 6,000 are vacant. The vacancies are due to turnover, money shortages, and lack of qualified staff. The number of vacancies appears especially acute in the veterinary medicine and agricultural economics areas. In addition, the SAUs appear to have particulardifficulty recruiting and keeping staff in their outlying field stations, especially those that are remote from urbanservices.

Prospective ICAR scientists are selected after taking examinations (offered in 57 disciplines) and being interviewed by selection boards made up of SAU and ICAR scientists. Those scientists selected are then sent to NAARM in Hyderabad for additional management-oriented training, followed by assignment to an institute in need of their expertise. In contrast, university scientists are hired by processes that vary considerably from one university to another.

SAU graduates have found employment in a wide range of occupations. In many states, the majority of graduates areemployed in state government agricultural services. However,research services, academic institutions, banks, private businesses,and farms are also significant sources of employment. Manygraduates decide to pursue higher degrees. Most veterinary graduatesgo into state veterinary services. Private industry is asignificant source of employment for agricultural engineering graduates. In a number of states, SAU graduates are in key positions in state departments of agriculture.

4.3 Budgets and Sources of Funds

As Table 3 demonstrates, there is considerable variation among SAUs and over time in the size of the budget of thevarious SAUs. In 1975/1976, the highest budget per faculty memberwas found at Haryana Agricultural University, with nearly Rs. 240,000. This figure contrasts sharply with the Rs. 34,000per faculty member at Tamil Nadu Agricultural University. However, by 1985/1986, the Haryana figure had come down considerably, while that at Tamil Nadu had risen.

In addition, there are vast differences among the respective states in the proportion of the total university budget funded by the state. In 1986/1987 at Haryana, for example,over 80 percent

of the total budget was provided by the state, in contrast to only 40 percent at Rajendra Agricultural University. Similarly, the portion of the budget funded byICAR varies considerably among SAUs, peaking at 41 percent at Rajendrain 1986/1987, while accounting for only 12 percent at Mahatma Phule. Given that ICAR funds are targeted for specificprojects and programs, as opposed to the formula-based supportprovided in the United States, these differences are perhaps notsurprising.

4.4 Libraries

Table 3.
University Budgets at Selected State Agricultural Universities, 1975/1976 and 1986/1987 or Most Recent Year Available

(Table not available. To view table, please order Document Number PNAAX206 in paper or microfiche.)

Libraries are an important part of any university for professors, researchers, and students. They are also the focus for much formal scientific communication. Table 4 shows the number of books and journals in 1976 and 1984 at the 10 institutions examined in depth for this study. As the table demonstrates, there are considerable differences in the size of SAU libraries. Moreover, the size of some SAU libraries declined from 1976 to 1984 as universities have split into two ormore institutions. Of particular concern is the small and inadequate collection of journals at some institutions, because these are the lifeblood of scientific communication.

Given the large and increasing size of some of the SAU collections, there is a need for a national interlibraryloan system and perhaps a national catalogue of SAU library collections. This issue is discussed further in Section 10.1.8.

Table 4. Library Collections of Books and Journals at Selected State Agricultural Universities, 1976 and 1984

	1976		1984		Percent Changes 1976-1984	
SAU	Number of Books	Number of Journals	Number of Books	Number of Journals	Books	Journals
GBPAU	170,294	1,671	254,929	1,762	50	5
MSU	148,722	966	86,953	270	-42	-72
OUAT	93,266	228	112,549	375	21	64
APAU	81,144	612	142,000	--	75	--
UAS	125,430	1,268	115,657	1,330	-8	5
JNKVV	126,633	--	132,698	--	5	--
MPKV	18,657	300	35,671	--	91	--
HAU	99,299	1,192	120,914	1,798	22	51

RAU	48,227	223	78,241	802	62	260
TNAU	94,072	713	120,853	1,104	28	55

Note: SAU acronyms are defined in the Glossary.

Sources: ICAR (1978, 164-165) and Association of Indian Universities (1985).

4.5 Recent Program Developments

Two major programs of significance have been started in recent years at the SAUs as well as at the National Research Institutes. These are the National Agricultural ResearchProject and the Centers of Excellence Program, funded by the WorldBank and the United Nations Development Program (UNDP), respectively. The National Agricultural Research project is designed to strengthen the regional research capabilities ofthe SAUs. As such, since its formation in the late 1970s, the project has sought to develop field stations in India'svarious agroclimatic zones and serve as a link between the research conducted on the SAU central campuses and the activities ofthe state agricultural extension staff.

The Centers of Excellence program, supported by UNDP, aims to improve selected areas of postgraduate education. It has attempted to create Centers of Excellence in particular research areas (e.g., agricultural microbiology, mariculture, dairy processing) that are too specialized or too expensive to duplicate throughout India and that would serve to provide qualified scientists for other research being conducted at the various SAUs and National Research Institutes (see UNDP 1985).

5. CONFORMITY OF STATE AGRICULTURAL UNIVERSITIES WITH THE MODEL ACT

5.1 Historical Background

The Indian state agricultural universities (SAUs) were modeled, as noted above, on the U.S. land-grant university system. The Blueprint for a Rural University in India(1956) by Dean Harold Hannah of the College of Agriculture of the University of Illinois (one of the first Americans to serve in India under A.I.D. auspices) as well as Hannah's later works(Hannah 1966; Hannah and Caughey 1967) were influential in thedevelopment of India's Model Act and in defining the role of India's SAUs.

In the Blueprint, Hannah described the administrative structure and functions of the various parts of a U.S.land-grant university by using the University of Illinois as a model. He also developed a suggested legislative statute, physical plant, and even cost estimates. Following the report of the University Education Commission (UEC 1962), those interested in the development of an agricultural higher education system in India emphasized that these universities were to be rural universities.

Dr. K.L. Butterfield, Dean of Rhode Island State College at the turn of the century, is quoted at length on this point. Butterfield noted that "The College must have a vision of the rural problem in its entirety.... We know that this ultimate question cannot be expressed alone by the terms nitrogen, or balanced rations, or costs per bushel, but must be written also in terms of the human problem of the men and women on the farm" (quoted in Hannah 1956, 25). Although Hannah was careful to point out that the U.S. land-grant model had to be adaptedto the Indian context, he was familiar with the UEC report as well as that of the joint Indo-American team (ICAR 1955) and so was careful to avoid making specific suggestions for such modifications.

Although many of the features of the Indian institutions resemble their U.S. land-grant university counterparts, the institutional transfer process was marked by significant differences in perception on both sides. Given the minimal experience of both the United States and India with such institutional transfer activities, this is perhaps not surprising. However, it is useful to clarify these differences in perception, because they both explain some of the present differences between the two systems and can help to avoid future confusion.

The concept of institution-building that was developed in the United States in the 1960s was a form of socialengineering. Its expressed goal was to effect rapid social change indeveloping countries by working with elites in a top-down fashion: "The [institution building] model is an elitist theory with an explicit social engineering bias. Changes occur from the top down, not from the bottom up, and they are guided by persons with a measure of official authority or sanction" (Esman 1972,26). Why such a model should have been so quickly embraced foruse in relations between two democratic nations is a matter that future historians will undoubtedly ponder. In this case, however, the strongly top-down orientation of the institution- building model was lessened by virtue of the strong Indian initiative.

On the American side, this institution-building endeavor meant that A.I.D. contracted with individual U.S. universities to develop counterpart institutions in India. It was assumed that the U.S. land-grant university system would perform as well in other cultural settings as it had in the United States. But as one of the participants, Elmer Kiehl, noted as early as 1967:

> The U.S. universities may have assumed too much from the start that they knew what was needed and they knew how to do it. The "land-grant" banner was carried high and too literally; it was not recognized that the task was more than a simple "transplant" job. ... The many difficulties and possibilities of error in trying to transplant our ideas or to establish new patterns in a culture so different from ours was not anticipated. Now, in looking back, the universities wonder why so much was assumed (Kiehl 1967, 9).

What went unnoticed, even by Hannah in his Blueprint (1956), was that the U.S. land-grant universities were embedded in a complex institutional matrix that included organized farmgroups that lobbied at the state and Federal levels for funding for agricultural research and education; a diverse, far-flung system of agricultural credit; effective suppliers of agricultural inputs and processors of agricultural outputs; a farm constituency that was virtually entirely market oriented; an efficient system of transport of agricultural commodities; and well-organized markets. Also ignored were the rising educational levels of the U.S. farm population and the increasing prevalence of radio and television broadcasting. Finally,little was made of the fact (though it is briefly mentioned byHannah) that by the late 1950s all U.S. land-grant universities had become comprehensive universities in which colleges of agriculture were only one component. However, the inclusionof colleges of basic sciences and humanities were recommendedto those seeking to establish land-grant universities in India.

In addition, the period of institutional transfer ended at about the same time that both internal and external criticism of the land-grant university system began to mount within the United States. As a result of the sharp break in Indo-American relations at the time, the SAUs were unable to benefit from this criticism. The criticism focused on several themes,including the tendency of the research conducted at the land-grantuniversities to benefit larger producers at the expense of smaller ones; the level and appropriateness of linkages between the universities and the agribusiness community (e.g., input suppliers); the lack of attention to the negativeconsequences of widespread use of farm chemicals on both the environment andthe health and safety of farmers and farmworkers; the minimalsupport given to the social sciences; and the lack of basic research (Carson 1962; Pound 1972; Hightower 1973). More recently, criticism has focused on the tendency for the land-grantmission to become submerged and forgotten within the larger state university complex, as agriculture becomes an ever smallerportion of the overall university program (see, for example, Schuh1986).

The validity of many of these criticisms was hotly disputed, and not until the latter part of the 1970s werethey taken seriously and changes introduced in response to them. In particular, many land-grant universities established environmental science programs, entomology was significantly redirected away from a sole reliance on chemical control and toward integrated pest management, and basic research programs(especially in the biosciences) were enlarged. More recently, theSocial Science Agricultural Agenda Project has attempted to raisethe visibility of the social sciences in agriculture. TheNational Agriculture and Renewable Resources Curriculum Project hasbegun a significant revision of the curriculum in the areas ofagricultural systems and ethics. Finally, some land-grant universities have established special programs targeted at smaller producers. However, none of these issues was underdiscussion when India's SAUs were developed.

On the Indian side, the differences in perception consisted of a tendency to erroneously view the U.S. land-grantuniversity system as a centrally coordinated and directed system with most authority residing in Washington, D.C. at the U.S.Department of Agriculture. This perception -- albeit mistaken -- is notsurprising given the greater central control over universities that existed in colonial India. This misperception is apparent in the report written by several distinguished Indian visitors to the United States in 1958 (Vaidyanathan and Naik 1958). Finally, this mistaken perception of centralized control of the U.S. land-grant university system became the basis for thepresent Indian SAU system, characterized by much greater central control than in the U.S. system.

Many Indians also misperceived the concept of a land-grant university, thinking it to mean that the U.S. Government gave each university a grant of land on which to build a campus and from which to grow enough to support the institution. In fact, the U.S. land-grant universities were given grants of Government owned land in the western United States that they could then sell to provide a small endowment for the university. Most funds came from annual appropriations of state and Federal legislatures, as they still do today.

Finally, certain peculiarities of the U.S. system that were the subject of experimentation during the 1950s (e.g., the trimester or quarter system) were erroneously seen as central to the system. (In fact, today most land-grant universities have returned to the semester system for a variety of reasons.)

Today, more than 20 years after the founding of the first Indian SAU, many of these differences in perception still persist on both sides. These differing perceptions explain some of the variations among the SAUs in internal organization,state funding, and effectiveness. For example, in some states the trimester system is still considered by some as an essentialpart of the "U.S. model" and is zealously guarded; in otherstates, it has been abandoned. Similarly, in some states the lack of a sufficient land base on which to grow crops for sale is seen by some as a deviation from the American model. In other states, legislators see a large experiment station and ask why state appropriations are still necessary.

Several other issues have arisen that affect the implementation of the Model Act by the various states. These issues include the establishment of multiple SAUs within a state,ICAR policy toward the SAUs, and disputes over a variety oforganizational issues. Each of these issues is examined below.

5.2 Multiple State Agricultural Universities Within a State

Although The Model Act specifies that only one SAU shall be established in each state, many states have established multiple SAUs. In other states, multiple campuses of each SAU have been established. Such proliferation does have its advantages: it spreads access to higher agricultural education throughout the state, permits a considerable increase in enrollment, enables

state politicians to show that they are doing something for their district, and permits the SAUs, in principle, to get closer to the rural sector in their respective states.

On the negative side, the proliferation of SAUs and SAU campuses has spread already limited resources too thin, particularly in the poorer states. This proliferation isparticularly problematic in the higher degree programs, which require specialized equipment and up-to-date library resources. Ithas also created considerable diseconomies of scale with respectto use of central university facilities and administration. For example, having multiple SAUs or campuses necessitates many libraries within a state instead of one. Similarly,multicampus universities with internal evaluation systems createproblems with uniformity across the various campuses, leading to areliance on external evaluations. This type of organizational fragmentation, in turn, has led to a considerabledeterioration in the quality of higher agricultural education and researchin those states with multiple universities or campuses. Ultimately having large numbers of poorly trained graduates will affect the research output and caliber of civil servants and will undermine the effectiveness and political support accordedto the SAUs.

5.3 ICAR Policy and the Model Act

One result of the proliferation of SAUs and campuses is that many states now rely heavily on the Indian Council for Agricultural Research (ICAR) for most of their operating budgets. ICAR must decide if this is an effective use ofits funds, a decision that should be part of an overall reviewof ICAR's philosophy toward university assistance. Such a review should clarify what goals that assistance will serve.

One method for slowing or stopping the proliferation of SAUs and campuses would be to establish stricter accreditation procedures at the national level. However, accreditation procedures should not be used to restrict educational growth and development but to ensure graduates' achievement of a minimal level of competence. Another method would be for ICAR to insist that receipt of its funds be based on matching funds. A state's matching of funds could even be based in part on some indicator of the relative wealth of the state.

5.4 Organizational Issues

The role of the Model Act is by no means yet resolved. At many of the SAUs, debates continue over the value of the trimester system, disciplinary specialization, internalevaluations, and multiple examinations throughout the academic year. These debates are usually framed in terms of the "U.S.system." Unfortunately, the debates seem too often to focus onconformity with an abstract U.S. model, rather than on the relativecosts and benefits to students of various approaches. All toomany faculty appear to understand the form of the land-grant university system without

understanding its mission. Whatis needed is a more thorough discussion and examination of the goals ofthe Indian system and an evaluation of the relevant elements of British, U.S., and other models that can contribute toimprovement of the Indian model.

6. MAJOR ACHIEVEMENTS OF THE STATE AGRICULTURAL UNIVERSITIES

Over the 25 years of the Indian state agricultural universities (SAUs) existence, their achievements in the areas ofagricultural education, research, and extension have been numerous. Each area is examined below.

6.1 Education

1. Creation of one of the largest systems of agricultural universities in the world in less than 30 years. Although many of the SAUs were created out of much older agricultural colleges, the rapidity of their transformation into full-fledged, service oriented universities is virtually without parallel anywhere else in the world. This, without question, is one of India's greatest institutional achievements and a model for other developing nations to emulate.

2. Development of the capacity to train students through the Ph.D. level. Many of India's SAUs have not only developed substantial undergraduate programs but also excellent M.Sc.and Ph.D. programs as well. As a result, India is one of the few developing countries capable of offering Ph.D. programs in many of the agriculture-related sciences. In addition, the growth of basic science colleges at some of the SAUs has permitted a qualitative shift toward more analytical research. This will undoubtedly have long-term positive impacts on postgraduate education.

3. Introduction of significant practical experience into the curriculum. Many of the SAUs have begun to realize the importance of practical experience and have introduced it into the regular undergraduate curriculum. For example, Andhra Pradesh Agricultural University requires a ruralagricultural work experience, during which students live and work in a rural village for 5 to 6 months in their final semester. Pantnagar offers a six-credit course in "Practical Crop Production." Given the lack of agricultural experience of many undergraduates, such practical experience should prove of great value inensuring that agricultural education is relevant to the needs of rural India. Furthermore, undergraduates spoke enthusiastically about such hands-on programs.

One significant gap in these practicums is that students describe rather than analyze the rural communities they serve. Because SAU faculty prepare questions students are to ask the village population, students have little opportunity or motivation to understand the village as a whole. What is needed is an opportunity for students to understand decision-making atthe village and farm level and to learn from farmers' wealth of

practical knowledge of farm and village life.

As yet no one pattern of practical experience has emerged as most effective in the Indian context. However, the willingness of various SAUs to experiment with different forms of practicums should ensure that improvements will continue to be made.

6.2 Research

1. Development of a world-class agricultural scientific establishment. Over the last 30 years the SAUs, together with the Indian Council for Agricultural Research (ICAR), have established the second largest agricultural scientific establishment in the world. Moreover, this scientific establishment includes numerous scientists who are international leaders in various agricultural sciences. Few other nations, if any, can attest to achieving this within such a short time.

2. A significant contribution to the world's agricultural scientific literature. India now contributes a significant and growing share of the world's agricultural scientific literature, particularly in areas related to tropical agriculture.

3. Establishment of multidisciplinary regional research stations designed to provide support for technology transfer at the regional level. The National Agricultural Research Project stations have served in many states to bring the university and its resources much closer to the problems encountered in India's diverse ecological regions.

6.3 Extension

1. Provision of technical support to the state extension services. Compared with the situation 30 years ago, the state extension services can now draw on the considerable expertise developed within their respective SAUs. This improvement undoubtedly provides more depth and breadth to agricultural extension than was previously available and offers the potential for spurring continued growth in Indian agriculture. The higher levels of expertise also ensure that extension agents can provide accurate information to villagers, thereby increasing the agents' credibility.

2. Creation and support of extension demonstration projects. The SAUs have also taken on numerous extension demonstration projects. This development represents asignificant advance in ensuring that the practices recommended to state extension services are relevant to farmers and have been proven successful by university faculty and staff.

3. Contributing to the unification of agricultural education, research, and extension activities within the same ministry so as to improve linkages between the three activities. Very early in the process of SAU development, the Indian Government decided to incorporate agricultural education and research activities into the ministry responsible for agricultural extension. This action

has eliminated many of the problems encountered in nations that have different ministries responsible foreach of these three activities.

7. FACTORS CONTRIBUTING TO THE ACHIEVEMENTS OF THE STATE AGRICULTURAL UNIVERSITIES

7.1 Leadership and Support From the Indian Council for Agricultural Research

The state agricultural university (SAU) system exists today primarily as a result of the leadership provided by the Indian Council for Agricultural Research (ICAR) in the formative stages of the development of the SAUs. As Propp stated, "If sufficient numbers of key Indians had not personally understood and believed in the applicability of the U.S. land-grant university concepts to Indian agricultural education, agricultural universities would never have been established" (1968, 6). From the beginning of the development of the SAU system, ICAR has been charged with providing the leadership that would set the various SAUs on the right path. Given its available resources, ICAR has done an admirable job. Moreover, some SAUs rely more heavily on ICAR (especially for funding) than do others. Thus, while ICAR provides less than a quarter of research funds to some SAUs,it provides more than 90 percent of the total funds to others. Research at these institutions is virtually dependent on ICAR funding.

7.2 State Government Support

Strong state government support, financial and otherwise, is a critical factor in the success achieved by the SAUs. Although no university (in any country) has all the funds it would like to have to carry out its various missions, there are marked differences among India's states in the level of support they accord to the SAUs. These differences largely account for many of the variations in effectiveness among the SAUs.

In some states, state funding of SAUs approaches 60 percent of the total SAU budget, whereas in other states it is as low as 20 percent. Moreover, state legislators who provide adequate support for their SAUs tend to understand that investmentsin SAUs are an investment in the state's future and not merely expenses to be borne. In addition, states that providestrong financial support for their SAUs also have strongcommitments to their rural sector and provide considerable monetary supportfor building rural infrastructure.

In sum, "The most important factor in our view which has vitally affected the growth of universities is the extent of State support. Wherever State Government has adopted apositive policy of trust and confidence in the university ... the university undoubtedly had made rapid strides" (ICAR 1978, 14).

7.3 Government Demand for Agriculture Graduates

Over the last several decades, the Indian Government and (especially) the governments of the various states have employed the majority of SAU graduates. This virtually constant demand (until recently) has helped justify the expense of establishing SAUs in each state. It also reinforced any existing strong desire for agricultural higher education.

7.4 Agrarian Structure

Indian states vary widely in their geography, land tenure, ethnic diversity, social structure, and political organization. As a result, generalizations about how these factors have encouraged or impeded the success of the SAUs are difficult to make. Nevertheless, SAUs appear to have had a more profound impact in states with more equitable and progressive systems of land tenure. Studies have shown that control over land by the cultivator (including most forms of land ownership), as opposed to tenancy or sharecropping, has a positive influence on rural development, perhaps because cultivators who control or own the land they till have a long-term interest in the improvement of agriculture. Conversely, many large absentee landlords have little interest in improvements in agricultural productivity and see land more as a source of wealth and power than as asource of income. In addition, states whose tillers control the land have better rural representation, ensuring that smallholder concerns are more easily heard.

7.5 Continuity and Commitment of University Leaders

Without question, there is a direct correlation between the quality of leadership exhibited by SAU administrators and the effectiveness of the university in building strong institutional support within the state and developing strong programs in agricultural instruction, research, and extension. Many SAUs have had long-term leadership by a series of articulate vice-chancellors committed to high-quality programs. These SAUs have tended to fare much better than those that have had a rapid turnover of top leaders. These administrators have been able to build the necessary rapport with state officials to ensure adequate funding of their institutions, and they have been able to motivate faculty to pursue the goals embodied in the Model Act.

In addition to top leadership, many SAUs have had excellent leaders at the dean and department chair levels. They, too,have played an important role in motivating faculty members and removing obstacles to excellence in agricultural instruction, research, and extension programs.

7.6 Assistance of U.S. Universities

Through A.I.D.'s financial support, eight of India's SAUs benefited from long-term association with a U.S. land-grant university during the 1960s and early 1970s. These associations were important in that they provided training for many of the first faculty members, fostered international collaboration, and

inculcated a sense of mission in the faculty of the new SAUs. In addition, the U.S. universities contributed to building local leadership and commitment through their faculty development programs.

7.7 World Bank and United Nations Development Program Support

The recent activities of the World Bank in the National Agricultural Research Project and the training and visit program have greatly helped the SAUs to address the needs of particular agroecological zones. These funds have also encouraged interaction between state departments of agriculture and SAUs on a scale previously difficult to achieve. The training and visit program has permitted the rapid growth of the extension services and an improvement in their effectiveness.

The United Nations Development Program's support for the establishment of centers of excellence in postgraduate education and research has helped participating SAUs maintain high standards and diversify their staff training.

7.8 Emphasis on Farmers

With the Model Act setting the stage for a clear emphasis on farmers, most of the SAUs have successfully incorporated this approach into their missions. This emphasis is apparent in most of the research accomplished at the SAUs as well as in their integration of research and extension activities. However,in agricultural instruction, the emphasis on farmers is not as widespread; while some SAUs provide higher education for the sons and daughters of farmers, others provide this education largely for urban dwellers.

7.9 Development of Linkages With Other Institutions

Nearly all of the SAUs appear to have established good relations with their state's extension services, which is clearly essential to effective extension. In some states, excellent linkages have also been forged with the state departments of agriculture, veterinary services, and fisheries. A considerably smaller number of the SAUs have been able to create linkages to international agencies such as the various international agricultural research centers. All of these linkages will help to improve the environment in which the SAUs function.

7.10 Pool of High-Quality Students

Competition to enter nearly all fields of higher education is severe in India. Although medical education is clearly most desired by Indian students, the competition to enter the SAUs is also quite keen. In many SAUs, less than 1 in 10 applicants is admitted. The availability of this large pool of high-quality students attests to the great strides made in Indian secondary education since independence and ensures that the SAUs are able to train many of the brightest students for work in agriculture.

7.11 Openness to Evaluation

The effectiveness of the SAUs is also positively correlated with their openness to both internal and external evaluation. Although no continuing and permanent system of evaluation exists at any of the SAUs, some have been more open to such evaluation than have others. Those more receptive SAUs have rightly seen evaluations not as a threat to the autonomy of the university but as an opportunity to improve existing programs and develop new ones in pursuit of their mission.

8. IMPACTS OF STATE AGRICULTURAL UNIVERSITIES ON AGRICULTURE AND THE LIFE OF THE PEOPLE

Because of their achievements, India's state agricultural universities (SAUs) have had considerable positive impact on agriculture and rural life in India. Even during the brief team visits to the 10 selected SAUs, many of these impacts became apparent. Some of them are documented below.

8.1 Impacts Through Undergraduate and Graduate Students

1. Improved poultry, egg, and milk production. Throughout India, consumption of poultry, eggs, and milk has risen considerably in the last several decades. The SAUs are largely responsible for this considerable change through their graduates, who staff the veterinary and animal production services.

2. Increased opportunities for women -- even in agronomy and animal sciences. In many of the SAUs, it is now common forhalf of the undergraduate class to be women. These women are demonstrating daily that they are capable of engaging in all activities in which their male counterparts participate. They are also forging new role models for Indian women that will have a profound effect in the near future. Given that much of the farm work in India is undertaken by women, the entry of these trained women into the agricultural services is likely to have a considerable positive impact on rural life.

3. Development of trained staff for government services. Throughout the agricultural services in all the states, itis now common to find SAU graduates. This transformation of that sector's work force means that these services employ better-educated, more competent persons than they once didand that they are likely to deliver their services more effectively. Among the services now staffed at least in part by SAU graduates arestate extension services, animal health services, research services, and in states with bachelor of technology programs in agricultural engineering, department of irrigation services (especially services in command area development).

4. Foreign students. The SAUs are also participating in the training of foreign students from other developing nations. Although the number of foreign students at each university is fairly small, this training represents a significant effort

toward helping those nations, which are often too small to have their own colleges.

5. Parastatal organizations and private companies. Although the number of SAU graduates employed in the private sector is not nearly as large as found in the state sector,SAU graduates have made a considerable impact on parastatal organizations and private agribusiness companies, including banks, credit agencies, and financial institutions. For example,SAU graduates can now be found in the milk processing, fishcanning, fertilizer, seed, food processing, agrochemical, and agricultural machinery industries as well as in many banks.

6. New business development. A few SAU graduates have started their own businesses as a result of their agricultural education. These businesses include small seed companies, consulting firms, urban landscaping companies, pumpset distributions and sales companies, one agrochemical giant, and numerous farm enterprises. Of import is that many of these former students are among the most fervent supporters of the SAUsystem.

8.2 Impacts Through Research

Research has contributed markedly to the development and growth of Indian agriculture over the last 25 years. However, given the close relationship between the Indian Council for Agricultural Research (ICAR) and the SAUs, it is impossible to sort out what proportion of the changes in Indian agriculture are attributable to ICAR and what portion to the various SAUs. Hence, except where noted, the figures described below pertain to both the SAUs and ICAR laboratories.

A 1973 study using a total factor productivity approach estimated that India's rate of return on investments in research had exceeded 50 percent per year, a return far above that of most other public investments (Evenson and Jha 1973). A similar study several years later revealed an equally high rate of return(Kahlon et al. 1977). A study is now underway to update these figures.

However, it should be noted that research in India has focused on the major cereals: wheat, rice, sorghum, andpearl millet. From 1948 to 1964, these crops accounted for nearly 50 percent of all research experiments (at the SAUs and ICAR labratories); from 1965 to 1970, they accounted for 48 percent (see Deo 1987 for more details). The reports of the review team suggest that this research focus has not changed greatly since 1970, a perception that should be kept in mind when considering the research accomplishments of the SAUs.

8.2.1 Research Institutions

Over the past several years, the SAUs have developed regional research stations in numerous agroclimatic zones,in part as a result of the National Agricultural Research project. These stations have enabled the SAUs to move closer to the problems of

the farmers in their respective states and to foster a closer link between research and extension. The impact of both the regional and central campus research stations is considerable.

8.2.2 Research Conducted for State Agencies

Several of the SAUs have reached a level of credibility in their respective states and even within the international community that has enabled them to attract grants, contracts, and endowments. For example, Tamil Nadu Agricultural University has secured funds to support endowed chairs from the state banks as well as grants from several international organizations. Similarly, Orissa University of Science and Technology has conducted a series of 15 impact studies for state agencies, which has resulted in improvements in the allocation of state resources.

8.2.3 Livestock

1. Use of artificial insemination to improve cattle breeding. As a result of SAU research and extension,artificial insemination, which was once rarely employed, has become a rather commonplace activity. As a result, the quality of dairyherds throughout the nation has been considerably upgraded.

2. Milk production. Many states have experienced major increases in milk production. For example, milk production in Orissa has risen 100 percent in the last decade. In Bihar,milk production is up by 40 percent. Much of this increase has resulted from improvements in the production of buffalo milk. For example, in the organized milk collection areas of Andhra Pradesh, 85 percent of the milk is from buffaloes.

3. Poultry and egg production. Because of increased production, eggs and poultry are now commonly found in the marketplace in many states. The wider availability of eggs and poultry is due in part to SAU research to develop improved breeds that can tolerate adverse environmental conditions. In addition, commercial poultry production has begun to take hold, with flocks of 5,000 broilers or 10,000 layers common in many states. Much of the increased production can be attributed to the impact of SAU graduates who are now working in the hatcheries.

4. Animal feed improvement. The improvement of animal feed is perhaps as important to increasing animal production as is the breeding of improved animals. SAU scientists have been successful in identifying new sources of animal feed from wastes and in improving rations at low cost.

5. Animal health. The changes in the field of animal health are perhaps best summed up by an Orissa University of Science and Technology researcher who noted that "fifteen years ago we had to chase after the farmers to treat their animals but today the farmers are seeking such treatment and vaccinations for their animals." SAU research has been particularly effective in reducing outbreaks of foot and mouth disease and in better

controlling outbreaks that do occur.

8.2.4 Crops

1. Wheat and rice. Increases in production have been most profound in areas where irrigated wheat and rice are major crops. This is not surprising given that these technologies received a head start as a result of Green Revolution research conducted in the 1960s. For example, over the last 20 years irrigated wheat production in Haryana has increased by 500 percent and rice production by 700 percent. As a result, wheat yields per hectare have doubled and rice yields have risenby 400 percent. Similarly, in Maharashtra, high-yielding seed varieties account for 67 percent of the rice and 77 percent of the wheat planted. In Andhra Pradesh, upland rice yields have reached 2,264 kilograms per hectare through the use of university-developed varieties. In sum, the SAUs have been at the forefront of major production gains in seed variety development, the conduct of adaptive trials, or refinements in cultivation, fertilizer, and disease control practices.

2. Other cereals. Sorghum and millet production has also increased in large part as a result of new seed varieties developed at the SAUs. For example, with 70 percent of the finger millet grown in Karnataka being the product of improved seed varieties, finger millet production in Karnataka increased by 101 percent between 1966 and 1984.

3. Soybeans. Soybeans were almost unknown in India 25 years ago. Today, they are of considerable agricultural importance in many states. For example, in Madhya Pradesh, soybeans cover over 1.1 million hectares. Moreover, two varieties oped at Jahawaharlal Nehru Krishi Vishwa Vidyalaya are planted in 70 percent of the total area under soybean cultivation in Madhya Pradesh.

4. Horticultural crops. Many of the SAUs have begun to recognize the importance of horticultural crops including both fruits and vegetables. Although they have not as yet given much emphasis to marketing, these SAUs have begun to emphasize horticultural crop production, particularly in areas near major cities. Many of these improved horticultural crops are beginning to make their way into the countryside through agricultural extension schemes. Crops such as table grapes, ber fruit, custard apples, apples, and numerous vegetables have been improved through the efforts of the SAU scientists. In addition, many of the universities now offer horticulture degrees.

5. Foundation seed production. Several of the SAUs have been very active in the production and distribution ofbreeders' seed and planting materials. For example, Mohanlal Sukadia University in Rajasthan has two seed farms that produce mostof the improved seed available in that state. In other states, private companies have begun to take over this job, a trendthat is likely to continue (see Pray 1984).

6. Resolution of crop micronutrient shortages. Although macronutrient recommendations for most areas of India have been established for some time, work on micronutrients is more recent. Several of the SAUs have played a not inconsiderable role in identifying these micronutrients (e.g., zinc, sulfur, manganese, copper) and in adjusting fertilizer recommendations to meet requirements for these micronutrients. For example, research at Jawaharlal Nehru Krishi Vishwa Vidyalaya helped to rectify zinc deficiencies in some areas of Madya Pradesh, thus increasing crop yields. At G.B. Pant University of Agriculture and Technology as well, zinc deficiences have been identified and corrected.

7. Cropping intensity. Through the use of better management practices, many areas in which only one crop was previously possible are now able to harvest two crops (rabi andkharif). In irrigated areas, three crops are now commonly grown through better rotational practices.

8. Use of fertilizer and biofertilizers. The SAUs have played a role in making fertilizer recommendations for various crops, although for many reasons these are not alwaysfollowed in full by farmers. Many of the SAUs have also developed and released strains of rhizobia and other biofertilizers that have been widely distributed among farmers. These biofertilizers are replacing costly chemical fertilizers.

9. Biological control. By their nature, biological control initiatives are location-specific. Many of the SAUsvisited by the review teams have made significant progress inselected areas of biological control of insects and other pests. For example, Orissa University for Science and Technologyreported development and successful release of wasp pupae as acontrol for caterpillars that attack coconuts, resulting insignificant yield losses. Control of this problem has increased farming income considerably. Similarly, Tamil Nadu Agricultural University has reported success in using integrated pest control strategies on cotton. Eighty percent of cotton producersnow use such techniques, saving an estimated 10 million rupees per year in that state. Finally, Haryana Agricultural Universitymakes extensive use of biological controls to reduce sugar insect pests.

Research and development of biological control products is important because India has little domestic petroleum, the base for most farm chemicals. However, biological control is of more than economic importance in the Indian context because of the general population's lack of understanding of the toxicity of farm chemicals and, as a result, misuse of such chemicals. For example, a study of chemical residue in foods in the Udaipur market revealed that 70 percent contained levels above those considered safe by the World Health Organization.

8.2.5 Agricultural Engineering

Given the small size of most Indian farms, designing suitable equipment has been a difficult task. Although results are uneven

(and not all universities have agricultural engineering programs), there have been some significant successes indeveloping agricultural equipment. For example, a multicrop thresher developed at G.B. Pant University combines the axial flow concept developed at International Rice Research Institute and a grate system developed at an SAU. This machine is capable of threshing a variety of crops, including wheat and paddy, for which it has been widely adopted. In addition, many of the SAUs have developed improved hand tools that are widely used throughout India.

8.2.6 Fisheries

In many of the SAUs visited by the review teams, the fisheries colleges were too new to have demonstrated manyresults. However, in some states, fisheries colleges that have been established for some time have made considerablecontributions. For example, the fisheries college at the University of Agricultural Sciences at Bangalore, Karnataka, has developed new forms of feed using locally available materials, has identified handling procedures that reduce the risk of biological contamination of the catch, and has developed new methods of fish preservation. These practices have been widely adopted in the state.

8.2.7 Home Science

Despite the general weakness of the home science colleges (see Section 10.4), several of these colleges are conducting considerable research of importance, especially in the area of food use and nutrition. For example, the home science college at Andhra Pradesh Agricultural University has conducted surveys of food-use patterns and preferences as a guide to its research and extension planning.

8.3 Impacts Through Extension

1. Technical dissemination through extension specialists. The SAUs now employ large numbers of agricultural extension specialists, who provide a link between research scientists and extension workers. They also have played a key role in increasing the effectiveness of the state extension services.

2. Creation of farmer demand as a result of radio and television programs, use of bulletins in local languages,and annual farmer's fairs. One of the key impacts of the SAUs on extension has occurred through the creation of farmer demand for extension services. In many states, farmers are now likely to come to extension agencies with their problems rather than passively waiting for the local extension agent to come to them. This change suggests the beginning of a new phase in extension education.

3. Development of infrastructure for extension. As a result of university short courses, correspondence courses, meetings, and hands-on instruction, the overall quality of agricultural extension appears to have improved markedly. This is especially

the case in states that have close ties between the SAUs and the extension service.

4. In-service training for veterinarians. This training is delivered through SAU-sponsored summer institutes and other short courses to update veterinarians on the latest developments in their field.

5. Tribal area development. The SAU extension programs have made a significant impact on tribal agriculture. Included are the development of aromatic grasses as hill coverings in Orissa, which provide soil cover and reduce erosion while providing new sources of income to smallholders. InKarnataka, tribal areas have benefited from the development ofsericulture and vegetable production.

6. Scheduled castes. As with tribal areas, SAUs have also had some positive impact on scheduled castes. Much of this impact has involved helping smallholders to identify more suitable crops to grow on small plots and providing landless laborers with the know-how to raise goats and other animals. One project at Rajendra Agricultural University has been successful in helping landless laborers acquire small herds of cattle.

8.4 Impacts Through Banks

Banks are a significant feature of rural India because they are required by law to make a certain percentage of their loans to smallholders and landless laborers. Because of the knowledge held by SAU graduates who now work for them, India's banks are better able to assess the viability of projects for which farmers request loans. Loans may be as small as for the purchase of a single animal. Several SAUs also provide regularly scheduled training programs for bank personnel to keep them up to date on the latest agricultural practices and recommendations.

8.5 Impacts Through Effects on Policy

Several of the SAUs have begun to contribute to state-level policy formation. Participation in policymaking has been important at both Haryana and Punjab Agricultural Universities for some time. In addition, Tamil Nadu Agricultural University has assisted the state of Tamil Nadu in coping with the problems of irrigation water distribution that have occurred as a result of the prolonged drought in that and neighboring states. This assistance has significantly increased the state's ability to plan and manage the agricultural sector. Similarly, the University of Agricultural Sciences at Bangalore has been instrumental in conducting a study of state landholding patterns in order to help legislators assess the effects of a bill to change those patterns.

8.6 Impact on Lower Agricultural Education

At least one SAU (Mahatma Phule Krishi Vidyapeeth) has responsibility for much of the lower agricultural education in

Maharashtra. The university runs training programs of from 1 week to 2 years to train people for a wide variety of agricultural sector jobs, ranging from village-level social work to machinery repair. This is a very worthwhile activity for the university to pursue, because it helps the university to ensure high quality among extension personnel and high school agriculture teachers. In the long run, this program should pay high dividends to the university. Other SAUs have also begun to develop programs in lower agricultural education. Forexample, the college of agricultural engineering at Rajendra Agricultural University has initiated courses for unemployed rural youths in agricultural machinery repair. Similarly, Mohanlal Sukadia University offers short courses in electric motor repair and motorbike maintenance.

9. THE CHANGING CONTEXT OF WORLD AGRICULTURE AND INSTITUTES OF AGRICULTURAL HIGHER EDUCATION

As the discussion in Sections 6-8 makes clear, the achievements and impacts of the state agricultural university (SAU) system in India have been substantial, especially given the extraordinarily short period of its existence. India is now a nation able to feed itself; it possesses the second largest agricultural research system in the world, in which the SAUs play a considerable role; and it has produced graduates at the undergraduate and postgraduate levels who have met its employment needs in both state and national agricultural services. These successes have been due in part to the support and understanding provided by the Indian Council for Agricultural Research (ICAR) and the various state governments, and in part to the leadership displayed at the national, state, and university levels.

However, all nations of the world are now facing a rapidly changing world agriculture. In a volatile world market for agricultural commodities of all kinds, new technological changes can make previously distinct commodities interchangeable,such as the substitutability of palm, coconut, and soy oil in the manufacture of bread. In some cases, the higher levels of agricultural production have been accompanied by severe environmental deterioration, including soil erosion, aquifer depletion, deforestation, chemical pollution, and destruction of the wildlife habitats. The linkages between agriculture,industry, and the service sector are being reexamined as the problem of finding employment and income for all has taken on global proportions.

Worldwide, agricultural educational institutions need to be able to respond to a new and rapidly changing social,political, economic, cultural, ecological, and technological environment. Such a response will entail complementing the traditional emphasis on production increases with a commensurate concern for advances in productivity and sustainability. Several steps in this direction have already been taken by individual scientists who recognize that agriculture needs to move away from an exclusive commodity focus to a greater emphasis on the development of new agricultural systems. These systems need to include not merely the production of agricultural commodities but

their integration with other activities of the farm household. Such systems must also encompass markets for the sale of agricultural commodities and facilities for their processing, the delivery of farm inputs, availability of credit, state and national resource and agricultural policies, and an ability to meet urban food needs.

Restructuring agricultural universities throughout the world to meet these challenges requires not merely the addition of new departments (although that may be necessary as well), but consideration of new ways of knowing as well as new kinds of knowledge. For example, a whole range of new theories of knowledge and its diffusion now exists, encompassing major changes in cognitive theory, the theory of research, and the philosophy of science. These new theories suggest that there are multiple ways by which knowledge can be created, each of which is relevant and appropriate under different circumstances.

Moreover, scientific thinking is shifting from a reductionist focus on the parts to a focus on the whole, where knowledge about how the parts fit together is given as much if not more weight than knowledge about the parts. Furthermore, to borrow a metaphor from biology, development is being reconceptualized as the co-evolution of people with their environments; that is, people and their institutions do not simply exist, but are constantly responding to changes in their social and natural environments. These changes, in turn, change the environment again in a continuing process of co-evolution and co-development.

The import of this change in theory and perspective is that agricultural universities are no longer viewed (by themselves or by others) as places where knowledge is created by scientists, handed to students or extension workers, and in turn passed on to farmers. Instead, as universities struggle to remain relevant to future needs, they are developing new approaches, curricula, paradigms, theories, and practices, based on the active participation of all as learners. In other words, agricultural universities are being redefined as resource centers, where there is simultaneous learning by all actors -- students, faculty, farmers, public officials, and others -- about the real issues faced by the agricultural and rural sector.

9.1 Strategic Planning

The problems and responsibilities facing all agricultural universities, including those in India, are such that they can only succeed if they become proactive, which means that faculty and their leaders must vigorously monitor and interact with their environment so as to ensure the success of the university mission. Such an endeavor requires redefining the ways in which agricultural universities function such that impacts rathe rthan outputs are the criteria of success.

If, for example, one wishes to achieve the impact of raised incomes among smallholders, then interdisciplinary teams need not only to design new technologies but also to modify the rural

social, economic, and physical environment to achieve that goal. An agricultural university could accomplish this by conducting socioeconomic studies of barriers to increased income, by educating state legislators and officials on how their institutions could be made more effective, or by negotiating directly with other state and national government agencies.

Only by marshalling the capabilities of all members of the university and by building in mechanisms for response to change can faculty and students effect change in the agricultural sector. This means that planning and evaluation cannot be activities engaged in once every year or 5 years but must become a central feature of a university's ongoing activities. Similarly, priority setting must be given greater weight than it has had in the past. To achieve positive impacts also means that individual and organizational learning must be designed into the institutional fabric; instead of emphasizing knowledge, we need to emphasize ways of knowing.

Designing these new types of agricultural universities will not be easy because no nation now has them in abundance. However, we hope that one outcome of this evaluation will be to stimulate a dialogue between agricultural faculty and administrators in many countries about how to create more effective higher agricultural educational institutions. Issues to be considered in efforts to create such institutions are discussed below.

1. Participation in organizational change. Considerable research indicates that organizational change is most effective and lasting when it is the product of widespread participation of people from all strata within the organization. Moreover,it is unfair to expect only top administrators to effect organizational change -- everyone needs to be exposed not only to new visions but to strategies for thinking about new visions. The kind of fundamental change needed in institutes of agricultural higher education is one that challenges world views, paradigms, and epistemological stances. This is an inherently disturbing phenomenon for it forces people to question those things thought to be beyond question.

2. Continuing education for faculty. Continuing education for faculty is essential if agricultural universities are to keep pace with the rapid changes in science and agriculture. Scientist exchange programs, sabbatical leaves, teaching seminars, increased attendance at scientific meetings, and collaborative research projects and programs were proposed by many individuals interviewed by the review teams as measures for ensuring that faculty remain abreast of the latest developments in their respective fields. What forms such exchanges and collaborative research might take deserves careful consideration.

3. Monitoring university impacts. Another aspect of strategic planning is the need to document the impacts of agricultural university programs and projects. All too often, agricultural universities have only vague information on the success of adoption of recommended techniques and practices. However, these

universities need such information to document their successes, correct their mistakes, and show state and national government officials that agricultural education, research, and extension are investments in the future of the state and nation and not simply costs to be borne.

9.2 Building New Constituencies

Agricultural universities worldwide will only flourish to the extent that they build constituent groups in their respective nations and states. The organization of farmers into clubs or other groups (already underway in some Indian states) is essential to the political support of the agricultural universities. It also offers an excellent vehicle by which farmers can make their needs and demands known to university scientists.

In India, the National Agricultural Research Project provides great potential for this type of activity. Similarly, the monthly meetings between farmers, researchers, and extension workers as part of the training and visit system present an excellent opportunity for building new constituencies. A final possibility is offered by the National Academy for Agricultural Research Management (NAARM), which has the potential to develop a system of client education that would be particularly valuable in providing state government officials with a greater understanding of the role of SAUs in rural development.

10. PROBLEMS, OPPORTUNITIES, AND ISSUES FACING STATE AGRICULTURAL UNIVERSITIES

The problems of establishing an institution and those of maintaining it are often quite different, as demonstrated by India's state agricultural universities (SAUs). The first 25 years of the SAU system have been a period of establishment and definition of the organizations' structure, size, and external relations. The problems now faced by many of the SAUs, especially those established in the 1960s, are those of mature organizations. Although, as mature organizations, the SAUs enjoy the advantages of having established procedures for entering new relationships, they also must address the disadvantages that result from organizational inertia. In this light, the issues raised below by faculty, administrators, and others in the numerous interviews with the review teams must be seen as the consequences of success of the SAU system rather than as the demonstration of its failure.

10.1 University Management

10.1.1 Isolation

Although the SAUs are part of a system coordinated by the Indian Council for Agricultural Research (ICAR), they suffer from considerable isolation, which hampers their ability to accomplish their missions. This isolation is manifested in several ways.

First, the SAUs are isolated from each other. There is little opportunity for scientist-to-scientist contact across state boundaries or even among universities within the same state. It was often observed in the interviews that scientists working in similar agroclimatic zones in adjoining states were unaware of each other's research and published works. Moreover, this professional isolation is exacerbated by the tendency for scientists to have received all their undergraduate and postgraduate training at the institution at which they currently are employed.

Second, the various SAUs are isolated from ICAR. In general, only senior scientists and vice-chancellors have opportunities to participate in national meetings sponsored by ICAR. In contrast, junior scientists rarely have opportunities to leave their campuses to attend regional or national meetings. Moreover, the lack of participation at annual meetings of disciplinary societies or interdisciplinary research groups tends to place an undue burden on ICAR to ensure the communication of scientific research.

Third, the Indian agricultural scientific research community is isolated from the world community. It is to the credit of the Indian system that nearly all Ph.D.-degree candidates are now trained in India. However, the lack of exposure to scientific communities in other nations through pre- and post- doctoral education, travel to foreign meetings, scientist-to-scientist contact, and joint research projects on issues of international concern has reduced the effectiveness of the Indian scientific community. Furthermore, at some universities this situation is worsened by the lack of adequate access to foreign (or even domestic) journals in the university library.

Fourth, the students at most of the SAUs come from the respective state. (An exception is G.B. Pant University, where 10 percent of the seats are reserved for students from out of state and, in practice, a far larger percentage of out-of-state students pass a national entrance examination and are admitted.) This has the effect of perpetuating the linguistic, ethnic,and cultural barriers that block the development of a truly national system of SAUs. It also means that the student bodies are more parochial than they might otherwise be.

10.1.2 Centralization

The SAUs have grown rapidly since the creation of the first institution in 1960. Not surprisingly, in the beginning it was necessary for these institutions to receive constant support and nourishment from ICAR. Even now, some of the newer institutions undoubtedly require this type of support. However, many of the SAUs are now large, well-established institutions with large faculties and well-developed programs.

For several reasons, these institutions now need to be able to assert their independence to a greater degree than before. First,

ICAR can no longer engage in detailed management of the everyday affairs of a system of more than 20 institutions spread over a huge nation. As the organizational study of ICAR noted some years ago, "with about 30 research institutes,laboratories, and centres, 17 agricultural universities, and about 70 projects ICAR cannot function centrally and must take steps to decentralise its working" (Chowdhry, Gaikwad, and Bhattacharyya 1972, 21). Since the time of that study, the SAU system has grown even more. Second, attempts to engage in such detailed management divert ICAR from its more important role of planning and coordinating the overall direction of the SAU system and helping the newer institutions to grow and mature.

ICAR's role is complicated by the fact that the level of organizational development varies considerably among the SAUs. Although most of the older institutions are now well-established and self-directed, many of the the newer ones still require substantial guidance from ICAR. This means that the types of support that ICAR provides will have to vary across institutions.

The development of a stronger role for the Association of University Vice-Chancellors is clearly a step in the right direction. This organization has tremendous potential to grow into an important independent force for agricultural and rural development. Over the next decade, the association needs to become a full partner with ICAR in developing future goals for the SAUs and ensuring that India's rural development needs are met.

10.1.3 State Support

There is great variation in the states' financial support of their respective SAUs. At first glance, this appears to be largely due to the significant differences in wealth and agricultural productivity among the states. In particular, states in which the Green Revolution boosted agricultural production appear to spend more on agricultural research and education. However, in some states, state funding of SAUs as a proportion of the total SAU budget has been declining, in part because the development of additional SAUs or campuses has depleted already limited state resources. State resources are so limited in Madhya Pradesh that the university has a debt of 70 million rupees.

There is little or no educational value in creating multiple campuses if all will be poorly supported and educational quality will necessarily be poor. Such institutions will not only be ineffective, but they will also erode intellectual standards and waste scarce state funds. (It should be noted that U.S. land-grant institutions faced precisely the same problems in their formative years. They were only able to resist compromises to academic quality in most cases because of the strong support they received from the Federal government. (See Busch and Lacy 1983.)

The need for vigorous leadership in the SAUs was mentioned by many SAU scientists as important in educating legislators about

the importance of agricultural university funding. In some states, where legislators and top officials are from agricultural backgrounds, this task has been easier to accomplish than in states where legislators have little appreciation for agriculture.

10.1.4 Understanding of Mission

Despite the rather clear language of the Model Act, many SAU faculty members had difficulty articulating their SAU'smission. They often appeared unaware that the purpose of their institution was to aid in India's development and not merely to generate new knowledge about or train students in agriculture. Related to this lack of understanding of mission was an overwhelming curriculum orientation toward production agriculture, with other subjects and issues often viewed as secondary to those of production. Although this approach was a necessary and appropriate response to food shortages in the early days of the SAUs, today the universities are hampered by this narrow focus.

The lack of understanding of mission was also apparent in the huge number of research projects underway at nearly all SAUs. The colleges of the various SAUs often appear to be large collections of independent investigators, each pursuing his or her own interests. There appears to be no sufficiently effective mechanism for establishing research priorities based on the mission of the respective SAU and its colleges.

10.1.5 Building Leadership

Review teams' discussions with various informants have noted the tendency toward frequent rotation of certain staff positions. For example, deans are often rotated after only 3 years in office. In some SAUs even the vice-chancellor has a term of only 3 years. Similarly, extension faculty often work on 3-year contracts.

Having such short terms is particularly problematic when faculty occupy high-level administrative posts. Because their time in office is so short, and because others with different ideas will follow them, faculty serving in such positions are reluctant to effect real change. Although it is clear that very long terms of office can lead to stagnation, such short terms can lead to a lack of understanding of the system and an inability to effect needed change.

Another aspect of leadership of the SAUs is the tendency to place undue burdens on leaders. Often, deans and vice-chancellors felt compelled to personally involve themselves in nearly all of the daily decision-making of the college or SAU. Given the large size of the SAUs institutions, this is simply no longer feasible. By delegating more authority and responsibility, the leaders of SAUs can lessen the burdens of leadership and spend more time making institutional policy decisions than in addressing details of management.

Finally, many of the present generation of SAU leaders received their education abroad and may have a somewhat broader vision of agricultural universities than do their younger colleagues. As this older generation nears retirement, more thought needs to be given to exposing the next generation to agricultural education in other nations.

10.1.6 Faculty Quality and Vacant Positions

Faculty quality is a function of recruiting the best persons available for the job, rewarding them for performance, and supporting their professional development. Currently, the SAUs face problems on each of these counts.

Recruiting Faculty. There is a marked tendency to recruit faculty almost entirely from within the state, in part as a result of linguistic and ethnic differences. In practice, this means that new faculty are former students of the SAU that employs them and that there is little competition for a given position. This is equally the case for positions at the associate and full professor levels, because retirement and other benefits are not transferable across state boundaries.

Handling recruitment in this way has several damaging effects. First, it creates a situation in which scientists spend much of their professional career under the tutelage of their mentor, which discourages the independent thinking that is the lifeblood of science. Second, scientists are not exposed to ideas developed at other SAUs other than through the literature and formal contacts, thus stifling the informal relations so essential to science. Third, there is an overall decline in the quality of the scientific staff as their exposure to new ideas declines. Moreover, the SAUs have a less diverse faculty than they might otherwise have, and, arguably, they do not always hire the best person for the position advertised. In at least one SAU this type of professional inbreeding was regarded as natural.

Most SAU administrators are aware that this recruitment approach has created a problem, and define it as such. Some SAUs have instituted measures to try to remedy this situation. For example, the University of Agricultural Science at Bangalore sent 10 students out of state for M.Sc. and Ph.D. training in the hopes that they will return and fill critically needed faculty positions at the university, bringing with them a broadened perspective. However, this approach may be insufficient to resolve the problem.

The Reward System. Promotion criteria do not appear to reflect the central mission of the SAUs. Promotions and salary increases appear to be based on the number of years inservice rather than on productivity. This practice is reflected in the low level of publication among SAU scientists (about one article per 10 scientists per year) and may even serve to discourage the best scientists and teachers as they see less competent colleagues receiving the same rewards that they do. Improving the reward system will be difficult, given that the current system offers

the security of lifelong employment and salary, not insignificant values in Indian society. It should also be noted that limited job opportunities encourage this type of reward system. Moreover, this problem was noted as early as the first joint Indo-American team report (ICAR 1955).

Whatever approach is taken to improve the reward system in India's SAUs, it should be remembered that merit must include more than simply publishing in prestigious international journals. Any improved merit system must take into account the individual's performance in teaching, extension, public service, and research functions. It must also consider whether the individual is serving the goals and mission of the institution as defined in its charter.

Another issue to be examined in any revision of the present reward system is whether all faculty should be paid according to the same schedule. Given the high demand for graduates in certain fields, it may be impossible to maintain quality programs if the present arrangements continue. Also, to be resolved is whether the SAUs should develop procedures to allow scientists to supplement their salaries. For example, the university-based consulting group at Orissa University of Science and Technology provides one such model.

Faculty Development. Each field of science is constantly in flux, as a result of new discoveries, new methods, new theories, and changes in other fields. In addition, teaching methods and approaches are also changing. As a result, faculty need opportunities to improve their skills and competencies if they are to grow intellectually. Faculty development may consist of in-service short courses, attendance at professional national and international meetings, sabbatical leaves, and postdoctoral studies. Although the SAUs have made some efforts in this direction, and the National Academy for Agricultural Research Management (NAARM) has begun to lead such efforts (see Section 4.1), more could be done to keep faculty at the cutting edge of research.

Vacant Positions. Many institutions reported large numbers of vacant positions, which have created severe shortages of trained staff in some areas. For example, at G.B. Pant University only 43 of 86 agricultural extension positions are filled. Significantly, nearly all of the vacant positions are at offcampus extension sites. Moreover, no housing and only limited transportation is available at these sites. Given the isolation of the extension sites, it is not surprising that extension specialists attempt to transfer to Pantnagar's main campus as soon as possible.

Similarly, their are numerous vacant positions in the departments of veterinary science and agricultural economics at many campuses. In both cases, M.Sc. or even B.Sc. graduates can obtain better paying positions than can new Ph.Ds. in these fields. There is a need to increase undergraduate training to meet the demand in these fields.

Ironically, although many positions remain vacant at the various SAUs, funds are not available to them to support their programs in ways other than filling such positions (e.g., by hiring temporary staff or by enlarging the research budgets of scientists currently employed). Thus, vacant positions reduce the SAUs' potential effectiveness not only because there are fewer faculty available to meet SAU needs, but also because funds cannot be reallocated to improve the work of currently employed staff.

10.1.7 Evaluation

In general, the SAUs lack a system of continuous evaluation and review. This problem extends from the university as a whole, to the individual departments and colleges, to teaching, extension, and research programs and projects.

In a recent survey of agricultural faculty, Balaguru and Rajagopalan (1986b) noted that scientists generally believe that projects are completed if final reports are submitted or articles are published in scientific journals. Moreover, they found that there was often little feedback to the scientists on the value of their research. This shortcoming was noted in an earlier ICAR report (1978), as well as in a recent article by an SAU vice-chancellor (Rao 1987). One Vice-Chancellor, quoted in that article, sums up the issue: "The need to evaluate the research based on the utility to the end users can hardly be overemphasized" (Rao 1987, 49). Although evaluation of research represents a positive step in itself, the greater need is to regularize and institutionalize both internal and external evaluations of all aspects of the SAU programs.

10.1.8 Information Availability and Transfer

The Indian agricultural research system is one of the largest in the world. SAU and National Research Institute libraries contain literally millions of research documents. ICAR and the SAUs publish numerous reports and scientific journals; thousands of agricultural research projects are underway at any given time. Yet ICAR lacks any system for monitoring its far-flung and decentralized enterprise. (An exception ist he computerized budgetary data system currently being assembled by ICAR.)

Given the enormous advances and cost reductions in computer equipment in recent years, it appears that some serious thought should be given to developing a central library catalogue (see ICAR 1978, 94), a project data base, and a budget/scientist monitoring system, with systemwide access. These developments would permit the instantaneous identification of research on a given subject, the identification of scientists appropriate to specific projects/programs, and the adjustment of budget and scientist allocations to the changing needs of Indian agriculture.

Because of NAARM's emerging role in such efforts (see Section 4.1), it would appear to be the likely candidate for developing

such a documentation system. Moreover, the proposed system should be used to coordinate rather than to centralize decisionmaking, which would reinforce India's preestablished preference for a decentralized system in which research decisions are made at many levels.

10.1.9 Universities as Suppliers of Foundation Seed

Although serving as suppliers of foundation seed has proven to be a significant source of income for the SAUs, it may detract from their research and education mission. Yet insome cases, this activity may increase the SAU's autonomy. The dilemma lies in deciding to what extent the SAUs should supply seed in cases where the private sector could do so.

10.2 Role of Women in Development

Although women are very active in India's economic life, they are not well-represented in its institutions, professions, or student bodies. Women constitute an enormous proportion of India's agricultural labor and are responsible for nearly all of the food processing and preparation that occurs on the farm. Yet, few women serve as agricultural extension workers (one exception is in Karnataka, where there are now 130 women extension agents and 5 percent of the assistant agricultural officers are women), researchers, or administrators. This situation would be somewhat less serious were male extension workers able to communicate effectively with women. However, this is not the case, in part because of traditional attitudes in the villages. Without significant increases in the number of women in the ranks of extension personnel -- or significant attitudinal changes among male extension personnel -- many women will be left behind in agricultural development.

Some SAUs have recently begun to admit large numbers of women to their undergraduate programs in agronomy and animal science, areas traditionally reserved for men. Female enrollment in some states (e.g., Tamil Nadu) is about 40 percent, but in other states, for a variety of reasons, few women are enrolled in the SAU. In several instances, review teams were informed that this was the case because women could not do the fieldwork required of students. However, the large number of Indian women who daily toil in India's fields belies this rationale for excluding them from fieldwork. As the Deans' Committee recently suggested, "it is desirable to encourage girl students to join the professional degree in agriculture so that the training of rural women in modern agriculture is properly undertaken through women agricultural professionals" (ICAR1985, 23).

If offering new opportunities in agriculture for women is to be a part of the SAU mission, then even in states with significant female enrollments more needs to be done to ensure that women enter the extension services and that female farmers have the same access to extension as do their male counterparts. To do otherwise is to limit development to only half of India's agricultural and rural population.

10.3 The Social Sciences

When the SAUs were first established in the 1960s, the research emphasis was on increasing overall agricultural production to meet India's immediate food needs. What little social science capacity was established in the SAUs then focused almost exclusively on the diffusion and adoption of agricultural innovations. Today, the rural and agricultural sector in India is far more complex as a result of such factors as widespread rural industrialization, diversification of agricultural production in response to the demands of a growing middle class, better infrastructure, and more readily accessible credit. However, the social sciences within the SAUs have not kept pace with these changes, leaving their role within the mission of the SAUs ambiguous. The problem has several components.

First, the number of social scientists in India's SAUs is quite small, with some SAUs having virtually none at all. In others, social scientists are confined to providing service courses to agriculture undergraduates and thus have little opportunity for research and extension.

Second, the social scientists are not used as effectively as they could be. Few interdisciplinary research projects employ the skills of social scientists to define linkages between farmers' problems and technical research, to identify policy problems, to explore the management capabilities of farmers, or to make farmers' needs known to technical researchers. Similarly, few practicums utilize the skills that social scientists have to offer. Therefore, SAU students may spend 6 months or more in a village without gaining an understanding of village social structure or the economics of village farm management.

Third, social scientists are not available in sufficient numbers to document the rapid changes occurring in the villages or to suggest broad applied research strategies to technical scientists.

Fourth, due to the small number of social scientists, heavy teaching loads, and limited research budgets, social scientists are unable to address important policy issues or provide information increasingly sought by state and central government agencies (e.g., the effects of such factors as price policies, credit costs, water distribution systems, and transport costs on agricultural and rural development).

Fifth, social scientists (especially economists) are often attracted away from academic positions by the higher salaries offered by the banks. Thus, many SAUs have large numbers of vacant positions for social scientists.

Sixth, social scientists are to some extent suffering from a self-imposed professional isolation. Most social science studies in India are in the logical positivist tradition of describing and analyzing change rather than actively participating in it.

Developing action research strategies that explore alternative strategies for social change would put India's social scientists in the center of current issues in agriculture rather than at the periphery.

Finally, social scientists are not being used to evaluate the effectiveness of the SAUs' agricultural teaching, research, and extension programs and policies.

10.4 Home Science

Although there are a few outstanding exceptions, the home science programs in most of the SAUs are weak and confined to subjects at best inappropriate to the overall mission of the institution (see also ICAR 1978, 68-76). What is baffling is that the now largely abandoned U.S. home science model of the 1960s, never more than stereotypically accurate even for the United States, has become widely adopted in India, where a drive through the countryside immediately shows the fallacy of assuming that women's work is confined to the home. Indeed, given the needs of India's rural areas for improved nutrition, better diets, improved processing and preservation techniques for village use, better child care, agricultural education, and raising the status of women, the home science colleges -- if modified -- could play a crucial and significant role. However, as numerous reports have noted before (ICAR 1979), many of the home science colleges tend to cater to the needs of urban homemakers rather than to those of the rural population.

The lack of significant or relevant programs in the food technology or nutrition fields is apparent. Moreover, existing programs are often divorced from the production sciences,such that nutritional, esthetic, and preparation issues are injected only after the fact rather than as new varieties are developed. In addition, the problem is exacerbated by the minor role of home science in the state extension programs and the reluctance of state extension services to hire female graduates.

A related problem is the low status of home science among professionally oriented female students. These students tend to prefer medicine or technology as careers and accept home science only as a last resort. And, in SAUs where women are entering the production sciences in large numbers, it is likely that home science will become still more marginal as a field of choice.

By contrast, home science degrees are seen as acceptable by students who do not desire to pursue a career. As a result, students majoring in the home sciences are often among the weaker students at the SAUs, with many marrying soon after graduation and not pursuing a career. In short, the weaknesses of the home science colleges are exacerbated by the traditional attitudes toward home science held by many female students, as well as by the low expectations concerning women in these programs expressed by faculty in other disciplines and among rural people with whom home science graduates work.

10.5 Teaching Programs

10.5.1 The Quality of Teaching

Many students and faculty expressed concern over the quality of teaching at the SAUs. Although SAU students believed that their teachers were well qualified in their subject matter,they were frustrated by their over reliance on lectures, the rote memorization expected of them, and the lack of clear links between coursework and practical work. This emphasis on the didactic mode of teaching is likely to influence the outlook adopted by the graduates of the SAUs. Rather than seeing knowledge as something that is always changing to meet new situations, they are likely to see it as a set of fixed facts and principles that must be handed on to others. Given the dynamic and locational character of agricultural knowledge, other approaches to teaching and learning are sorely needed.

In addition, faculty tended to rely extensively on class notes rather than to complement instruction with library resources or texts. The lack of relevant textbooks on agriculture written by Indians for use in India is often given as a reason for using lecture methods. Moreover, some SAUs lack adequate audiovisual equipment or the knowledge to use it effectively.

Nevertheless, several SAUs are well aware of this problem and have attempted to correct it by establishing in-service teacher training courses for faculty and by establishing special problem-solving courses for students. (The course in development education developed by Dr. Sudarsanam [1987] at Tamil Nadu Agricultural University deserves special mention; see also Bisaliah 1987.)

10.5.2 Teaching Loads

Although simple student/faculty ratios would suggest that teaching loads are low, in fact the situation is otherwise. First, only a small proportion of the faculty have teaching responsibilities. Many are assigned to regional stations some distance from the central campus. Second, teaching loads for assistant professors are as high as 20 contact hours per week, which places the heaviest teaching load on those who might otherwise be the most productive researchers. Third, student course loads tend to be very heavy to compensate for the lack of textbooks. Faculty feel compelled to squeeze as much as possible into courses in order to "cover the material." Little time is left to devote to learning how to solve problems or to class discussion or debate. Fourth, with inadequate numbers of technicians for laboratory courses often the case, faculty members must assume the burden of setting up experiments for large classes.

Finally, there has been a tendency at some SAUs toward course proliferation, particularly at the graduate level,thus severely straining already limited faculty time. This problem is most evident in the basic and social sciences. Although this approach

was perhaps satisfactory when these fields existed only to provide a service to other discipline areas, many SAUs now offer M.Sc. and Ph.D. programs in these areas, yet do not provide faculty with adequate time for research. This not only affects the research program in these areas but also weakens their postgraduate programs.

10.5.3 Teaching Resources

A serious constraint to effective teaching is the lack of teaching resources, including textbooks, library resources, and audiovisual materials. Textbooks applicable to India are often lacking or, when available, are in very short supply; this appears to be true of all SAUs. The review teams found this puzzling, given the dynamic nature of the Indian publishing industry and the fact that the SAUs and National Research Institutes employ many persons qualified to write textbooks relevant to the Indian context. At some SAUs, constraints to effective teaching extend to audiovisual and library facilities as well. (We note that review teams visited only the more established SAUs;given the variation in constraints apparent at these institutions, it is more than likely that the newer SAUs are facing even more serious constraints.)

10.5.4 Student Commitment to Education

Student protests over the frequency of exams, the difficulty of the course material, and more trivial matters are not uncommon in the SAUs. Many faculty believe that educational standards have been lowered as a result of such protests. Given the immense pressure in India to succeed in school and the potential career that success can bring, it is notsurprising that students are easily frustrated. In addition, there is some difficulty in making the transition between secondary school and the university because of the need to adapt both to English as the sole language of instruction and to the "American system," with its frequent tests and many classes, its lack of externally administered exams, and its establishment of the instructor as the final authority in grading.

However, it is important to put these issues in perspective. Compared with India's general universities, the SAUs have been correctly described as "seas of tranquility." Overall, SAU students are enthusiastic about their education, proud of their institution, and serious about their studies. They often compare their education with that received by friends and relatives at general universities, almost invariably believing that SAU students are receiving the better education. Nevertheless, SAU students have few opportunities to contribute to the improvement of their own education. The development of methods and procedures for student evaluation of programs and courses would serve the twin goals of encouraging academic excellence and providing more constructive means for students to vent their frustrations. In short, students need to become more responsible for their own education.

10.5.5 Attracting Students From Rural Areas

Some SAUs have been far more successful than others in drawing students from rural areas and from agricultural back grounds. Those that have been successful have experienced considerably fewer academic and job placement problems, because such students are already familiar with rural environments and farming practices and are more likely to return to the farm or to become actively involved in other agricultural pursuits after graduation. Yet, "the important question with regard to admission procedures is how to ensure an increase in the number of candidates admitted from rural areas" (ICAR 1978, 23). As Harold Hannah noted 30 years ago, "Agricultural universities in India could do what land grant universities have done in the United States -- qualify young men and women from rural areas, with their fine traits and appreciation of hard work, for positions of leadership in all walks of life" (Hannah 1956, 14). Some SAUs have succeeded remarkably well in fulfilling this goal; others have much more to do toward this end.

10.6 The Research Program

10.6.1 Research Applicability

Although the effectiveness of the states' extension services has increased markedly with the infusion of large numbers of university graduates over the last several decades, and the extension education divisions of the SAUs have incorporated all the latest technical advances in their extension efforts (e.g., radio programs, videotapes, bulletins), extension is still largely a one-way activity in which information is provided by researchers to farmers but not the other way around. This is a self-imposed handicap that limits the effectiveness of both research and extension through a failure to appreciate farmers' knowledge as relevant to research and education efforts.

Evidence from numerous nations attests to the fact that farmers have vast stores of practical knowledge that can be of enormous help to scientists in developing improved technologies and management practices. For example, Iranian and Dalmatian (now part of Yugoslavia) farmers have grown pyrethrums (Chysanthemum cinerariefolium) alongside their crops for centuries for their insecticidal properties; yet only within the last 50 years has the biological insecticide in pyrethrums been identified and produced on a large scale (see Moore and Levy 1975). Similarly, in India companion planting of castor trees and chili peppers has been found to control white fly. Still another example is the widespread use of intercropping among farmers in the tropics. Although farmers in many parts of the world practice intercropping, little attention was paid to it until recently. Numerous experiments now show that intercropping often creates symbiotic relations between crops and reduces pest damage.

As a result of the lack of farmer input to agricultural research, all too often technology has been developed that is of high quality but inappropriate for the circumstances of farmers.

Needless to say, these technologies have not been adopted widely. No single technology is likely to apply to all farmers; farmers live and work in widely differing social and natural environments. However, greater attention to farmers' needs and desires would markedly increase the rate of adoption of new technologies. Developing the institutional mechanisms to do this will be a challenge for the next decade.

10.6.2 Yield Plateaus

Research conducted by the SAUs and ICAR research stations made possible an enormous increase in yields during the 1970s. However, during the 1980s, yields and total production of many crops have leveled off. New research strategies will be needed to ensure that yields continue to rise and that India remains self-sufficient in meeting its food needs. Accomplishing this will not be easy -- the easiest problems have already been tackled. India clearly has the trained research scientists to accomplish such a task, but it will require that agricultural research institutions receive greater resources than they have in the recent past.

10.6.3 Availability of Scientific Equipment and Laboratory Chemicals

The availability of scientific equipment in the SAUs appears significantly more limited than it is in the National Research Institutes. This equipment shortage also affects graduate education, especially in the biosciences. Although the number and range of graduate programs at the SAUs has expanded markedly over the last several decades, the availability of and support for equipment needed for graduate research has not kept pace. This shortage is particularly apparent with microcomputers. Given the easy availability of Indian-built microcomputers and their minimal maintenance requirements, considerable improvements in research productivity could be accomplished at low cost through their greater diffusion.

While much of the simpler scientific equipment is now made in India and can be easily maintained, more sophisticated equipment must still be imported. Generally, maintenance for imported equipment is problematic. (Nevertheless, it is of note that many of the SAUs still own equipment in working order that was provided under A.I.D. grants in the 1960s.) Each SAU has at least some nonfunctioning equipment, and some have much equipment in this state. More thought must be given to how much of the more sophisticated types of equipment is absolutely necessary to accomplish the tasks of the SAUs and how much could be accomplished with simpler equipment or through cooperative agreements with central laboratories.

Although an Indian laboratory chemical industry furnishes common laboratory chemicals to the SAUs, India does not produce biochemicals. These must be imported from Europe or the United States, a process that requires about 1 month and sometimes results in chemical spoilage in customs offices. For instance,

fragile enzymes cannot, for all practical purposes, be imported, because the customs process is too slow to accommodate them. Unless these barriers can be overcome, SAU and ICAR efforts to undertake research that requires the use of biochemicals and, especially, enzymes are likely to be impeded significantly.

10.6.4 International Linkages

Although many of the SAU senior staff were trained in the United States or elsewhere abroad during the 1960s, more recently hired staff received all their training in India. As the senior level staff begins to retire, informal scientific linkages with U.S. and other foreign institutions may deteriorate. Moreover, current faculty have few incentives for creating new linkages with other nations because such linkages provide few rewards to individual faculty members. Given the importance of these linkages for playing a role in the international scientific community and in avoiding the duplication of research, further investigation of the magnitude of this problem seems warranted.

10.6.5 Fragmentation

The organizational fragmentation of the various science disciplines at the SAUs is extensive. It is not uncommon to find departments of two or three persons at many SAUs, and many have plans for even more subdivision of disciplines. Communication across scientific disciplines is relatively limited at many SAUs, leading to duplication of research effort and research results that are not useful to farmers. Similarly, curricula are often fragmented, with little or no attempt to show student show the various curriculum parts are interrelated. Many scientists expressed concern about whether the mission of the SAUs is most effectively served with such a fragmented approach to research and education.

Disciplinary separation is particularly acute across the boundaries between agricultural, animal, social, engineering, and home sciences. For example, although a lack of feed is a key limiting factor to animal production, only a few SAUs offer interdisciplinary studies of the relative costs of animal feeds that involve both animal and plant scientists. Overcoming nutritional problems caused by the lack of good quality fodder will require considerable interdisciplinary research and coordination among forage agronomists, agroforesters, rumenphysiologists, and animal nutritionists. Few SAUs have the mechanisms in place for such interdisciplinary programs. Indeed, a few have their veterinary and agricultural units at separate campuses,which further further inhibits interdisciplinary research.

Except for ICAR awards for team research, few other mechanisms exist at the SAU level to reward or encourage interdisciplinary research. Indeed, the departmental structure at the SAUs is generally hierarchical, leading from department heads to deans and ultimately to the vice-chancellor. Few problem or issue-oriented committees or projects exist. This organizational

fragmentation has the unfortunate effect of limiting the use of already scarce resources for research and extension and of depriving students of a sense of how the agricultural and rural sectors of Indian society fit together.

A number of SAUs have attempted to address the problem. Tamil Nadu Agricultural University has developed centers for coordinating the work of various departments. G.B. Pant University has organized its scientists into informal program groups. Other possibilities that might be explored include merging small departments, developing a matrix organizational form, and reserving a certain portion of the university research budget for interdisciplinary activities.

10.6.6 All-India Projects

Some SAU researchers and administrators believe that ICAR's All-India projects are directed from the top down, with little opportunity for the SAUs to participate in their design. As a result, these researchers and administrators argue, these projects often fail to address local concerns and regional problems by adhering too rigidly to certain canons of scientific method. In their view, the all-India projects stress crop science research, while providing little opportunity for animal or social science research. However, because these projects provide supplemental funds to the SAUs, they are rarely rejected, especially in those states with grossly inadequate state appropriations for the SAUs. Thus, as was noted some years ago, the ICAR All-India projects often have the unintended effect of distorting state priorities rather than lending a national overview (Chowdry et al. 1972).

The problem may in part be the result of the SAU researchers' failure to distinguish among the three types of ICAR projects: (1) ICAR supported multilocation testing requiring careful coordination; (2) ICAR research programs, for which networking is appropriate; and (3) totally local projects, for which the use of ICAR funds is inappropriate. Clarifying the distinctions between these types of projects and ensuring that SAU researchers have a greater role in designing and implementing them would go a long way toward eliminating the problems that have developed.

10.6.7 Scale of New Technology

Given the small size of Indian farms, the scale of new technology is an issue of great concern. Although engineers designing agricultural equipment appear aware of the importance of considering scale, other scientists are often unaware of this issue. Even seeds and fertilizers have economies of scale associated with their transport and packaging. Consideration also needs to be given to the socioeconomic context in which technologies are to be used in order to fully appreciate the importance of scale. For example, a large tractor may be appropriate for use on small plots if it is cooperatively owned or hired on a custom basis. Conversely, more highly capitalized farmers have a distinct advantage in adopting crops that require

a high capital investment or a long delay before providing a return on investment (e.g., tree crops).

10.6.8 Research Funding

The University Grants Commission distributes grant funds to researchers at general universities throughout India. However, the commission does not normally distribute funds to SAUs -- on the grounds that ICAR is responsible for providing research funds for these institutions. Although this causes few problems for faculty in the production-oriented disciplines, scientists in the basic sciences, social sciences, and nonagricultural branches of engineering (e.g., food technology, processing) feel discriminated against by the commission as well as by ICAR. They believe that the commission perceives them to be covered by the ICAR funding umbrella but that ICAR provides them with inadequate funding to support their research. In contrast to the small funding levels available to these scientists, there are no restrictions on the level of funds tied to subject areas within ICAR. And in some areas of research, few scientists apply, leaving available funds untouched. Some resolution of this inequitable research funding will be necessary if the fields mentioned above are to be adequately supported in the future.

10.6.9 Field Stations

All SAUs visited by the review teams had numerous field stations. A common problem mentioned in the interviews was the lack of rewards (and, in some cases, the existence of real disincentives) for field station staff. Too often, field staff felt that they had been exiled to remote areas where they could accomplish little. In addition, these remote stations often lacked adequate housing, educational facilities for children of the staff, and basic medical facilities. Rarely was extra pay provided to compensate for these deficient services. In fact, at least one institution's field staff were paid less than their counterparts on the main campus. Clearly, effective field stations require personnel policies that provide moral support for the difficulty of working in the field and financial support to compensate for those difficulties.

A related issue is the number and size of the SAU field stations. Some might well argue that the number of stations in some states is far too large to be managed effectively. In contrast, some stations are so small as to make it impossible to have the required critical mass of researchers. In short, small stations with just a handful of researchers are rarely costeffective (Ruttan 1982); consideration should be given to closing such small units and conducting that research at larger stations.

10.7 Extension Education Program

We would have to agree with the 1978 ICAR report finding that "of the three functions, the extension link has remained particularly weak so far, and this has affected the capabilities

of many agricultural universities for transfer of technology to the farmers" (ICAR 1978, 13). This deficiency is of special importance because it limits the ability of the SAUs to fulfill their stated goals of extending research results to farmers and creating the means by which farmers can adopt such results.

The magnitude of the problem with agricultural extension is clarified by Table 5, which shows the large gap between the yield potential (as evidenced by national demonstration yields) and the national average yield for specific crops. This gap results from both physical limitations and biological and socio-economic factors (see, for example, Ruttan 1982, 311). Although itis virtually impossible to establish the proportion of the gap attributable to each factor, a very substantial proportion of the gap is clearly the result of biological and socioeconomic factors. Farmers are unlikely to adopt higher yielding varieties that do not contribute to overall farm income or that distribute labor unevenly over the season.

Improvements in extension are unlikely to be very effective unless the constraints on yield improvement are identified and removed. The SAUs could play a greater role in identifying the factors affecting yield improvement through their departments of extension and rural sociology (see also Kishore 1986).

Table 5. National Average Yields and National Demonstration Yields of Major Crops During 1971/1972-1979/1980 (quintals per hectare)

Crop	Average of National Average	National Demonstration Average	Highest Yields of National Demonstrations
Paddy	17.45	52.52	118.56
Wheat	13.77	36.66	81.95
Maize	10.28	34.16	80.49
Sorghum	6.12	37.69	74.61
Millet	4.35	25.18	49.66

Source: Prasad (1986, 6).

10.7.1 Farmer Contact

Extension education has paid some attention to adoption of agricultural innovation but has virtually ignored an examination of farmer needs. In many SAUs, only faculty in the extension education unit are in regular contact with farmers. This means that most faculty have few opportunities to continuously and directly confront the problems of farmers. Moreover, what contact does exist is often limited to a one-way flow of information from the extension specialist to the agent to the farmer. Balaguru and

Rajagopalan (1986a) report that only one-third of research projects have been developed from first-hand knowledge of farmers' problems or from field observations. Effective agricultural extension demands a two-way information flow because no researcher can assess the needs of farmers from his or her office.

As a result, extension services are largely reactive agencies that depend for their success entirely on the quality and relevance of the products and processes developed by research staff. However, by assessing farmer needs and providing that information to research staff, extension services would at once become proactive and have an easier job to do.

10.7.2 Responsibility for Extension

Few SAUs have studied the effectiveness of extension service delivery at either the organizational or the individual level. This is a logical and appropriate role for SAU extension educators to accept; however, it requires the maintenance of cordial relations between state extension services and the SAUs.

Furthermore, the SAUs and ICAR need to decide whether or to what degree the SAUs should undertake direct agricultural extension responsibilities. The development of clear policy guide-lines for interfacing with state extension services would be helpful. Such guidelines would be most useful if they emphasized how the SAUs can institutionalize methods and procedures for learning from farmers what their problems are.

10.7.3 Krishi Vigyan Kendras (Farm Science Centers)

The Farm Science Centers are designed to "impart learning through work-experience and hence ... [are] concerned with technical literacy..." (Prasad et al. 1985, 1). Many of the SAUs run such centers in areas near the university or its research stations. Although in principle this is an excellent idea, the complex nature of these organizations suggests that they are not replicable throughout India. SAU faculty often devote considerable time to working with just a handful of the centers, while ignoring those in the rest of their state. More thought needs to be given to designing extension methods that are cheaper and more rooted in village social structure.

10.7.4 The Lab-to-Land Program

The Lab-to-Land Program was established as a national effort to make scientists and their research more responsive to the needs of poor farmers. Although a worthy goal, it is not always apparent that it is fully appreciated by SAU scientists. At times, it appeared to the review teams that the program was seen as merely a means by which an SAU could fulfill its service obligation -- rather than as a means for developing and testing pilot projects that might be replicated on a larger scale. The program lacks upward communication from land to lab, and villages

are often adopted for program purposes for just a few years and then all contacts are severed. In addition, payments to program participants make it too expensive and unrealistic for the SAUs to administer. Often, as the program and the subsidy end, farmers return to their previous practices.

10.8 Lack of Job Opportunities for Graduates

In many states, the government market for SAU graduates with agriculture degrees is saturated. (This is not the case for veterinary and engineering graduates in most places.) For example, at Orissa University of Science and Technology alone, over 200 graduates have failed to find employment in the past 2 years. Some states have responded by restricting the number of new entrants into the SAU undergraduate programs. In other states, SAU students have demanded the creation of new state government posts. Given the enormous cultural importance placed on job security, it is understandable why government employment should be seen as most desirable.

However, bloating of the state agricultural services with unnecessary positions will only waste scarce resources and reduce their effectiveness. And more -- not fewer -- graduates are needed to support the growing Indian economy. This suggests that a restructuring of the undergraduate curriculum is needed so as to provide students with the necessary skills for employment outside of government agencies, including the skills needed to become farmers. It also suggests the need for innovative programs that would help SAU graduates establish small businesses to serve the growing agricultural sector.

This problem is all the more serious, given that it was first raised at length in the 1978 review of the SAUs (ICAR1978, 53-67). Yet most states have made little progress to date: certainly, the goal of 20 percent of SAU graduates seeking self-employment by 1983 (ICAR 1978, 62) has not been achieved. The problem is exacerbated by the fact that, in many states, most of the students come from urban areas and many are not interested in pursuing careers in agriculture or in rural areas.

Students also need to know what kinds of jobs are available to them. Although some SAUs have established placementoffices, all need to take on this important task.

11. FUTURE DIRECTIONS

As India approaches its fiftieth year as an independent nation, the state agricultural universities (SAUs) are reaching maturity. As such, they are already beginning to raise questions about their future as mature institutions.

11.1 New Sources of Funds

With few exceptions, the SAUs have been content to rely on two sources for their funding: the Indian Council for Agricultural Research (ICAR) and their respective state government. Although,

these entities will undoubtedly remain the key funding sources, several SAUs have begun to seek other sources of funds for their teaching, research, and extension programs. Among the potential funding sources are international foundations, public international agencies, state banks, alumni, and private companies. Contracts with state government agencies for particular types of research are also an alternative.

Although the SAUs should be more aggressive in identifying new sources of funds, they should be aware of the ethical problems at both the institutional and individual level associated with such endeavors. As public agencies, their role is to serve the public good and not to become wedded to narrow special interests. It would be helpful if the vice-chancellors were to develop flexible national guidelines for the solicitation and acceptance of such funds.

11.2 Agrarian Structure

Average farm size has been declining while India's population has continued to increase. At the same time new technologies can exacerbate this problem by encouraging successful farmers to increase the size of their holdings, thereby displacing others and leaving them landless. Unless jobs are available for those who are displaced, they may well be denied access to the means of of subsistence they had while still on the land. Moreover,in many states, the average farm size is far below what is needed to support is needed to support a family at even a modest standard of living. In addition, the population of landless laborers continues to grow.

While India's agricultural policies should respond to the special needs of these farmers and laborers, it is also clear that further rural development will have to involve the creation of rural, agriculture-based industries that can provide supplementary employment to farmers and laborers and eventually draw some people off the land. The SAUs need to redefine their role and mission to include a wider focus on such rural development activities.

11.3 New and Innovative Curricula

As the needs of the agricultural and rural sector change, SAU curricula need to be revised to remain relevant to national development needs. (See University of Agricultural Sciences 1987 for some ideas on improvement of agricultural education.) Already, some SAUs have taken steps in this direction, with the innovations at the College of New Education at Pantnagar representing one of many possible approaches. The key issue for any SAU revising its programs is to develop curricula that are more flexible in preparing students for a more diverse job market and future roles. Consideration should be given to including more coursework and practical experience in developing management skills, problem solving, and communications, even at the expense of somer eduction in the number of technical courses.

Developing curricula in management is perhaps central to the future educational needs of SAU graduate and undergraduate students. Many SAU graduates rapidly find themselves in positions where management skills are essential. For example, as extension staff members, bank officials, private entrepreneurs, or employees of large companies, SAU graduates are often placed in supervisory positions -- an area in which many alumni felt, at best, ill-prepared.

Development of an elective component at the undergraduate level (as recommended in the 1985 ICAR report) would be of great value. In particular, courses on how to establish and manage a small agricultural business (e.g., nursery development) could fill an important need.

However, simply adding courses on management that follow the same didactic approach used in most technical courses is unlikely to fulfill this need. What is needed is a reconsideration of the entire SAU teaching program. For example, should all students take the same program throughout their undergraduate education? If so, this implies that all graduates will have the same types of jobs (most likely, in the state governments). Yet, if the SAUs are to continue to contribute to Indian development, they need to set their horizons beyond solely providing manpower for the civil services.

This discussion suggests that numerous curriculum alternatives need to be offered to the SAU students. These student need to be provided with the skills and information that will allowt hem to choose among courses of study and to make some of the decisions that will affect their own futures. Indeed, this is a part of what management is all about -- the ability to make informed decisions. Moreover, one cannot teach decision-making by simply teaching about decisions; rather, students must learn decision making through making their own decisions (especially via field practicums) themselves and taking responsibility for them.

Some SAUs are located near campuses of other universities that offer courses complementary to those offered by the SAUs. For example, the University of Agricultual Sciences at Bangalore is located only a short distance from the Indian Institute of Management. In such cases of geographical proximity and academic compatability, the SAUs should arrange for their students to take appropriate courses at other universities. This would have the important advantage of broadening the SAU's program without requiring new resources.

The Center for Educational Technology as envisioned at Tamil Nadu Agricultural University represents yet a third approach to curriculum improvement. In fact, a network of such centers at each SAU, perhaps with coordination from the National Academy for Agricultural Research Management (NAARM), could play numerous important roles, as follows:

-- Researching and developing new curricula that reflect alternative cognitive theories and epistemologies, including

indigenous ways of knowing and knowledge as well as beliefs and values.

-- Evaluating existing and new curricula as an ongoing process of curriculum improvement.

-- Fostering innovative practices among faculty through workshops, seminars, and courses. This might include sending faculty to such a center on a rotating basis for periods of 1 year or more, so that they could be exposed to issues of learning theory, cognitive theory, and epistemology.

-- Developing improved methods of agricultural extension education (in cooperation with extension education and rural sociology faculty) that effectively integrate indigenous and scientific knowledge in furtherance of rural development.

-- Establishing education courses for students who will be teaching agriculture at secondary schools or agricultural technical schools.

Any such center should be more than just another unit of the SAU. It should occupy a central role in the organization of the university's teaching program. Only in this way will the continuous upgrading and evaluation of teaching become a regular part of SAU activities.

11.4 Agricultural Education and the Indian Council for Agricultural Research

An important consideration is whether ICAR should also assume agricultural education responsibilities. Although there is no guarantee that such a system would ensure more effective research-education linkages, it would unite both functions under the same organizational umbrella. This issue deserves further discussion inside ICAR and the SAUs, as well as with the various state departments of agriculture.

11.5 New International Linkages

Many of the SAUs have reached the stage in their development at which they could take on a more active role in educating scientists from other nations as well as engaging in joint research, extension, and education projects with them. The old model of institution building developed in the United States in the 1960s is out of date, and new models of sharing common problems are emerging. As a recent paper put it, "During the past decades, the flow of efforts tended to be one way and now this can be both ways. What is needed is a sort of framework for collaboration in and professional exchange for meaningful research" (Rajagopalan and Balasubramanian, 1987, 21). A central feature of any such new models must be the mutuality of benefits for all participants.

Collaboration can take a multiplicity of forms, including improving relations at the university, college, departmental, or

scientist level with respect to research programs, projects, or exchange of materials of interest. Collaboration might be disciplinary or interdisciplinary and might involve sharing curricula, research topics, or extension education via face-to-face contact or computer networks and conferencing. Faculty and graduate student exchanges might be established, perhaps involving two or more nations with similar needs and interests. In initiating any collaboration, full advantage should be taken of organizations such as NAARM, the United States' National Curriculum Task Force, the International Service for National Agricultural Research and other international bodies. Emerging agricultural policy in India now includes several specific areas of collaboration, including germplasm conservation, nontraditional crops, systems agriculture, and farm mechanization, including irrigation and biological control systems. These could easily be the foci for numerous long-term collaborative efforts.

Moreover, new institutional forms will need to be created to facilitate these endeavors. For example, the older U.S. model of collaboration, involving one university or a small group, is clearly inappropriate in the Indian context. Rather, new mechanisms for encouraging collaboration will need to be established within both ICAR and the various SAUs. New organizational forms such as joint commissions or foundations may need to be established to ensure that the best Indian and U.S. scientists cancollaborate on relevant projects, regardless of their institutional affiliations.

Collaboration with developing nations also offers India numerous possibilities. For example, the SAUs are already admitting foreign students to their undergraduate and graduate programs. This number could be expanded, perhaps with the help of external donor agencies. Foreign students would gain from the exposure to agricultural education in locales more closely related to their home environments. India would gain by creating goodwill in nations with similar environments, developing long-term collaboration with former students, and exposing Indian students to people from different nations. To support such efforts, the SAUs might consider developing a stronger international focus in their teaching programs.

With respect to research, the SAUs might wish to consider developing linkages under Government auspices with fledgling agricultural universities in other developing nations, especially many of the smaller African nations. These linkages might be at both the university-to-university level, where mutual concerns about university management could be discussed, and at the joint project and scientist-to-scientist levels. Still another possibility is the development of trilateral or multilateral projects and programs involving Indian, African, American, and other scientists.

11.6 Placement of Graduates

Only a few SAUs currently have placement offices. If the SAUs

are to serve the needs of employers other than state agencies, they will need to establish placement offices to help their graduates find jobs. At the same time, such offices could collect information from employers on the types of skills that SAU graduates should have and could monitor the flow of graduates into the economy. This information, in turn, could be used to restructure SAU curricula to more closely reflect India's economic realities.

The SAUs should also help create new employment opportunities in the private sector, including both self-employment and employment by input manufacturing and distribution and output processing industries; in new cooperatives for farmers that might be managed by SAU graduates; and in new services such as pest control, agricultural consulting, seed and seedling production, and urban horticulture. Development of such opportunities, however, must be accompanied by the adoption of a curriculum that provides the requisite management skills as well as, at least in some cases, cooperation from the banks in providing loans to graduates.

11.7 New Research Directions

11.7.1 The Role of the Indian Council for Agricultural Research

ICAR has played and will undoubtedly continue to play a critical role in the coordination and funding of SAU research. To date, most of that funding has been in the area of crop specific agricultural research. However, new concerns and priorities will be met effectively only if ICAR redirects its research funding to embrace areas now supported only occasionally, if at all. Moreover, interdisciplinary research efforts supported through ICAR are unlikely to succeed unless all disciplines involved are represented by scientists of comparable rank.

11.7.2 Systems Approach

Much of the research undertaken to date has been commodity or discipline oriented. This approach is effective particularly when dealing with monocropped fields -- as was and often still is the case for wheat and rice research. However, the problems now facing Indian farmers are more complex. They involve not only the production of a single commodity, but also the intercropping of several crops, development of new rotation systems,integration of animal and crop production (and in some cases forestry), more effective use of family labor, integration of farm and nonfarm activities, creation of new kinds of markets, development of new processing techniques, and changes in agricultural policies. A systems perspective is needed to ensure thatall the resources of the SAUs are simultaneously brought to bear on the most pressing problems of the states (see, for example, Bawden et al. 1984; Macadam and Bawden 1985).

Development of a systems perspective, however, requires more than simply developing new kinds of projects. It is essential

that the SAUs be restructured to reward systems research, principally through the formulation of interdisciplinary institutes that cut across traditional departmental lines. Development of new kinds of organizational structures will be a major challenge in the next decade (see UNDP 1985, 99).

11.7.3 Reevaluating Indigenous Knowledge

An unfortunate by-product of the transfer of Western science to non-Western nations is the devaluation of non-Western knowledges (Goonatilake 1982). Yet it should be apparent that the practical experience of millions of farmers in an extraordinarily diverse range of agroecosystems cannot be dismissed as irrelevant. Indeed, much farming practice worldwide is the result of decades or centuries of experience and not of scientific research.

In the West there is a search for new, holistic paradigms and ways of knowing to compensate for the limitations of reductionist perspectives. These new paradigms, whatever their form, emphasize the wholeness of the natural world and our part in it.

Inconducting this search, Westerners have drawn repeatedly on Eastern philosophies and religions. Unlike those of the West, Eastern philosophies capture the interwoven character of our world. As V.K.R.V.Rao noted, "The classic Indian tradition is to prefer the whole to the part; and one cannot see the parts in clear perspective except in the context of the whole."

Although India has an enormous resource of indigenous knowledge, this knowledge is not being adequately exploited. This is apparent in any village, where the difference between the best and the worst farmers is often substantial. If only half the farmers in every village were brought to the level of the best farmer in that village, overall agricultural production and crop yields would increase considerably. To accomplish this would require only the research necessary to identify why some farmers are more successful than others.

India also possesses an enormous range of fruits, vegetables, and cereals that have received scant world attention simply because they are unknown. These crops are part of the local ethnobotany but not of the scientific botany, and many of them hold great promise for improvement through conventional breeding strategies. Although they may actually produce even higher yields than more widely known crops in some areas of the country, it appears that little work is underway to explore India's vast crop resources.

In the past there has been a tendency to contrast the traditional farmer with the modern scientist. Tradition was -- and still is -- often seen as the source of the problem of underdevelopment. Science, somehow, seemed to stand outside tradition. Yet, what is science itself if not a tradition (or a series of traditions)? Just as no scientist would suggest that people without training (i.e., no inculcation in the traditions

of science) should work on scientific problems, no would-be farmer would try to farm without first apprenticing to an experienced farmer.

What this suggests is that both science and ancient agricultural practices are traditions. Both rely on information passed on by previous generations and modified in the light of new experience. From this perspective, it becomes immediately apparent that scientists can learn as much from farmers as farmers can from scientists, although just as farmers do not adopt all the practices the scientists recommend, we should not expect scientists to adopt all the practices that farmers use.

11.7.4 Improving Dryland Agriculture

Most of the great successes of the Green Revolution occurred on irrigated land. Even now, large areas could be irrigated, for which many projects are in progress throughout India. Nevertheless, much work needs to be done to improve India's dryland agriculture, especially in the areas of watershed management, alternative crops, and better drainage.

11.8 Discipline-Related Considerations

11.8.1 Horticulture: Marketing Research and Post-Harvest Handling and Processing

Fruit and vegetable production to supply urban food needs is becoming increasingly important given the enormous industrial growth of India's urban areas in recent years. As income levels rise, Indians are eating more fruits and vegetables and animal products. India's farmers, especially those living in the vicinity of the larger cities, have responded to this growing demand by turning to horticultural production. For example, apples, once a luxury outside the northern states, are now commonly available throughout India.

Yet, unlike grains, which can be stored relatively easily and for which the market is year-round and national (and even international), fruits and vegetables have short seasons and require more complex transport and marketing channels. Moreover, although large numbers of farmers can grow grains, only small numbers can grow any individual horticultural crop.

The SAUs could perform an invaluable service by conducting research on ways to improve these markets, thereby offering farmers greater incomes and urban dwellers greater variety in their diets. Such studies could also help the state and central governments to discern where public investments in agricultural infrastructure development will have the greatest returns.

There has also been little research on increasing the shelf-life of fruits and vegetables, especially those of tropical origin (e.g., custard apples, guavas). In fact, Prasad (1986b, 57) estimates that 20 to 30 percent of horticultural crops are lost because they cannot be consumed during a short harvest

season. The creation of improved processing and storage methods would enable more farmers to grow horticultural crops, would spread the season over a longer period, and would improve the diets of many people. This, in turn, would also improve the income of the farm population, a primary aim of the SAUs.

11.8.2 Home Science

Not all the SAUs have home science colleges, and given the difficulties surrounding this field, it may not be appropriate to establish more home science colleges. Instead, it might be more desirable to improve the existing home science colleges and to develop alternative structures at other SAUs that appeal to both men and women. Whatever approach is adopted, certain research areas need to be stressed, including studies on diet and nutrition in the villages, household labor needs, consumer preference and nutritional tests of new crop varieties, and the trade-offs between agricultural and domestic work.

11.8.3 Social Sciences and Humanities

Many of the most pressing problems facing Indian agriculture are not technological but social in nature. As early as 1949, the University Education Commission noted: "If these economic and hygienic advantages should be secured [for India'svillages] without corresponding development of character and culture, the change might be loss rather than gain. Economic, cultural, and ethical education must go together" (UEC 1962, 557).

The SAUs need to take the lead in developing full-fledged social science programs that include agricultural economics, agricultural business management, rural sociology, agricultural anthropology, agricultural policy studies, and agricultural ethics. A starting point could be the suggestion of the SAU Committee of Deans that 10 percent of the SAU curriculum be devoted to the social sciences (ICAR 1985, 7). Only in this way can the SAUs ensure that the education received by their graduates will prepare them to lead full and productive professional lives.Moreover, these social sciences need to be fully integrated into the agricultural-oriented programs of the SAUs so that social science skills are used to improve agricultural systems in each of the states.

11.8.4 Basic Sciences

Several of the SAUs have a basic science college, but many SAUs have no basic science program at all. Departments in the basic science colleges were initially designed to provide teaching services to the students in the colleges of agriculture. Only a few basic science colleges have significant research programs, and many SAUs have no basic science program at all. At present, many SAUs have nearly exhausted the current on-the-shelf technologies available for productivity improvement.

In the future, therefore, the SAUs will need mission-oriented

basic research to support their more applied research. Clearly, funds will not permit all SAUs to have complete basic science programs at this time. In addition, ICAR laboratories might perform some types of basic research for the SAU system as a whole. Thus, ICAR, in conjunction with the SAUs, needs to establish policy guidelines for a satisfactory division of labor between the SAUs and the National Research Centers. Such a policy must be cognizant of the relevant research being conducted at general universities in India and at universities and research institutes in other nations. The proposed National Council of Higher Education may prove to be an effective way of coordinating research activities across sectors and ministries.

Of particular importance to many SAU faculty is the West's recent shift to molecular biology, usually referred to as biotechnology. Biotechnology holds substantial promise for resolving some of India's more serious problems in the areas of animal health, plant breeding, biological control of insects and other pests, and food technology. However, biotechnology is more expensive to support and less specific in its geographic area of application than other agricultural research. Thus, if India is to become a serious contender in these new research areas,it must first be determined where India has a clear comparative advantage over other nations' research programs. In addition, although there are numerous questions of interest in biotechnological research, only a few are likely to lead to significant changes in agriculture. Thus, an effective biotechnology program will need to be linked closely to ongoing research in traditional subject areas.

11.8.5 Fisheries

Only two of the institutions visited by a review team have a fisheries college, one of which is quite new. The SAUs have given little attention to fisheries, considering its potential importance in a nation with thousands of kilometers of coastline and numerous large rivers. Research in this area could make an enormous contribution toward meeting India's food needs. However, research in and development of future fisheries necessitates an integrated approach, with attention paid not merely to increasing production but also to improving marketing and processing channels. Creation of a fisheries extension service is also essential if these colleges are to be effective in their designated role.

11.8.6 Animal Sciences

Because animals play a key role in the livelihood of many landless people in rural areas and even in cities, several pressing needs must be met by those in the animal sciences. First, the landless would benefit from research on low-cost, small-scale technologies that can help them to improve production of animals and animal products. The need for such research is recognized by most veterinary and animal science faculty members. At the same time, there are increasing demands on animal scientists for development and improvement of larger scale

commercial animal technologies such as broiler houses. Third, there is a need for the continuing provision of veterinary services for farm animals owned by both landless and landed farmers.

Veterinary colleges will need to balance these needs carefully, particularly because it will be all too easy to cater to the demands of large-scale producers or urban pet owners and to ignore the needs of smallholders and landless laborers. Perhaps urban pet owners and large-scale producers could be charged for services that would be provided free of cost to smallholders and landless laborers, with the fees generated being used to finance additional service provision to those unable to pay.

Related to this is the growing need for greater numbers of animal production and management (husbandry) specialists and scientists as a complement to the veterinary scientists. The services provided by such specialists will be increasingly important as commercial and small-scale animal production grows in importance. These specialists would emphasize experimental as opposed to clinical approaches to animal problems.

Currently, nearly all the animal research at the SAUs is clinical in nature. However, there is a need for a quantitative approach to disease surveillance, including more epidemiological research, so that the economic consequences of serious diseases can be determined. Although it is not clear what agency within the state or central government is responsible for accomplishing this task, this research can be used to determine the areas of greatest economic payoff from clinical and laboratory research.

11.9 Rural Development

Although several of the SAUs have made significant contributions to the rural development of their respective states,much remains to be done with respect to agricultural teaching, research, and extension. For example, research and extension leading to the development of new agriculture-based industries that can provide more job opportunities for underemployed farmers and farmworkers is essential. The emphasis of such applied research should be on developing off-farm employment linkages as well as helping entrepreneurs to develop small-scaleindustry. Other aspects of rural development research and education might include technologies that can improve the quality of life in rural homes, encourage proper child development, and improve sanitation and nutrition.

11.10 Environmental and Resource Management

Many of the SAUs are already addressing issues of environmental and resource management, including pesticide pollution,fertilizer runoff, soil erosion, salinization, deforestation, fuelwood management, and water management. However, work on these issues has been on a project-by-project basis rather than as part of an integrated program of research.

What is needed is an interdisciplinary attack on these issues, which would elevate their importance within the SAUs. The proposed Pant Institute of the Environmental Science at G.B. Pant University is indicative of the awareness ofthese issues by some scientists. The other SAUs need to follow suit with similar institutes to serve their research needs. Among the areas of particular importance are water management, soil conservation, pesticide pollution, and agroforestry. Each is considered in turn below.

11.10.1 Water Management

Water is a crucial aspect of agricultural development in India, but its availability is uneven and often unpredictable within a given season or region. Water management and use generally involve issues at the village, community, or even regional level rather than at an individual or farm level. Thus these issues require solutions that are the result of negotiation among large numbers of people. Consider some of the problems in water management seen by the review teams.

First, recently constructed dams in several states are silting far more rapidly than predicted as a result of deforestation in the watersheds above the dam sites. Resolution of this problem involves several issues, including (1) restriction of grazing and wood gathering above the dam, (2) construction of physical and biological barriers to slow the water flow into the dammed area, (3) more frequent dredging of dams, and (4)reduction in the number of farms drawing irrigation water from the dams.

Second, several areas of India have experienced a decline in the water table as underground aquifers have been over-pumped. In areas near the sea, this has led to salinization of the water supply. Resolution of the problem could require (1)restricting the quantities that can be pumped by existing wells, (2) prohibiting or restricting construction of new wells, and (3) closing existing wells based on some established criteria(e.g., the newest ones to be closed first).

Both examples show the complexity of water management. Although there are good technical explanations for the problems and good, multiple technical solutions are available to resolve them, resolution of the problems requires more than knowledge of the technical solution. What is needed is an interdisciplinary, policy-oriented study that can tailor solutions to the particular social, economic, and political realities of the state or region.

11.10.2 Soil Conservation

Soil erosion continues to be a major problem in much of India. As noted above, it accounts for many of the problems of silting in irrigation systems. Like water management, soil conservation requires not only that farmers be educated about its positive effects, but also that they have real incentives to adopt such measures. Development of such incentives will require multidisciplinary teams of scientists working closely with

policymakers.

11.10.3 Pesticide Pollution

Pesticide pollution is becoming an increasingly severe problem as more and more farmers learn about the effectiveness of pesticides and begin to apply them. Even in nations with highly educated farm populations, pesticide poisoning of farmers and farmworkers occurs all too frequently, and pesticide runoff pollutes waterways. The SAUs need to mount interdisciplinary programs (1) to identify the most common causes of pesticide pollution; (2) to design programs to eliminate those causes, including better education of farmers about the problems, substitution of biological for chemical control, banning of particularly dangerous pesticides, and the design of alternative procedures for use; and (3) to engage policymakers in a dialogue on the legal aspects of pesticide use.

11.10.4 Agroforestry

To date, the SAUs have devoted little attention to India's vast forest resources. Only a handful of forestry colleges exist, and they are oriented toward traditional forestry rather than agroforestry. Recently, however, interest in agroforestry has increased and several national projects have been developed to promote this effort. Attention must now be given to integrating agroforestry activities into the overall curriculum and programs of the SAUs.

11.11 New Directions in Agricultural Extension

11.11.1 The Role of Extension

Unlike the U.S. land-grant universities, the SAUs do not have responsibility for extension programs. These are essentially state activities that are technically supported by the SAUs and ICAR. A plethora of extension programs and methods are currently in use, including the Lab-to-Land Program, national demonstration schemes, operational research projects, Krishi Vigyan Kendras (farm science centers), zonal research stations, adopted villages, and the training and visit system. These numerous programs seem to have been designed at different times to embrace particular problems and issues. Many of the programs were quite large at their inception and then rapidly declined to relatively small-scale activities. For example, Gahawaharlal Nehru Krishi Vishwa Vidyalaya had 5,000 families in its Lab-to-Land Program in 1978, but it currently has only 300 participating families. In fact, few, if any, of the extension programs are actually statewide in scope.

Some thought needs to be given to the value of such a complex extension delivery system. In particular, the Lab-to-Land Program, which is extremely expensive and therefore limited in geographic scope, is perhaps no longer needed. Moreover, because this program gives free inputs to farmers, it may raise unrealistic expectations within the farming community. Perhaps a

smaller number of well-designed programs would be better able to reach the entire farming community.

In addition, more discussion is needed of the way in which research and extension interface. Clearer policy guidelines that define the demarcation between SAU extension responsibilities and those of the state departments of agriculture are essential for ensuring that the interface is one of cooperation and not duplication.

11.11.2 New Systems for Communicating Knowledge

In recent years, the training and visit system advocated by the World Bank has been widely adopted by state agricultural extension services. However, although this system may have been appropriate to a nation with a few simple technologies to diffuse to large numbers of smallholders, many extension specialists now argue that it has outlived its usefulness. A future challenge of no small consequence will be the design of new, more sophisticated agricultural extension methods, especially those that allow for dialogue between researcher and farmer.

12. CONCLUSION: BUILDING AN ENVIRONMENT CONDUCIVE TO DYNAMIC AND INNOVATIVE AGRICULTURAL UNIVERSITIES

There are at least three ways of viewing organizations: as self-contained entities, without much contact with or influence from their external environment; as entities that respond to a continuing array of pressures and requests from an external environment that may be friendly or hostile; or as active shapers of their own environment.

Throughout the world, many leaders of organizations still perceive organizations in terms of the first model. Because these leaders are largely concerned with the day-to-day internal dynamics of their organizations, they rarely have time to consider what is happening outside the organization. For organizations that have stable environments, this model may be quite appropriate.

A considerably smaller number of leaders subscribe to the second model. They see themselves as attempting to respond rapidly to any new potential opportunities or threats offered by the external environment. As such, they are able to guide their respective organizations through hard times and to take advantage of opportunities. However, they are content to wait for opportunities to come along, believing that they have little or no ability to create such opportunities.

Finally, a very small group of organizational leaders have discovered that successful organizations are those that seek to change their environment and so to markedly increase the probability of organizational success. These efforts may involve, for example, the generation of new consumer markets for innovative products and services that the organization seeks to offer, or it may entail more far-reaching efforts in changing

external institutional and policy conditions to support goals that the organization seeks to advance. In this context, leaders and their followers areengaged engaged in constant negotiation with important clients and constituencies, forming alliances, locating common interests, and mobilizing resources to achieve common interests. Like those who subscribe to the second model, leaders in the third category take advantage of opportunities, but they shape these opportunities to support a vision to which they and their followers aspire.

Many leaders of agricultural universities around the world fall into the first category. They receive a certain level of funds annually from their respective governments, which they use in about the same way as they did the year before. A smaller number are very effective in adhering to the second model, by attempting to respond rapidly to clients and in so doing increase their resources. However, these leaders achieve this at the expense of establishing coherent goals. Their goals become whatever their clients' goals happen to be at that time.

Finally, a small number of leaders of agricultural universities fall into the third category. They have a vision of what their institutions should be, who they should serve, what projects and programs they should undertake, and they actively seek support to further those ends.

Over the next decade the challenge facing India's state agricultural universities (SAUs) -- and most agricultural universities around the world including, without question, those in the United States -- is to move from model one or two to model three. Unfortunately, no blueprint exists for accomplishing a task of this magnitude, and those that have been successful in this effort have rarely analyzed the reasons for their success. Nevertheless, some guidelines can be put forward.

Perhaps the key feature enabling such change is political support from the central government that will permit the SAUs to develop into proactive organizations (see Coleman 1986). Without clearly demonstrated political support and commitment, the SAUs themselves are unlikely to accomplish much. Positive evidence of the importance of this commitment is found in the Government's decision to establish the SAUs in the 1950s. Negative evidence is found in the general failure of agricultural universities to become vehicles of development in most nations of Sub-Saharan Africa.

Also important to this process of organizational transformation is the formation of linkages between the SAUs and the other organizations in their immediate environment. These include state government agencies, national agencies, international agencies (such as the international agricultural research centers, foreign aid agencies, private voluntary organizations, universities in other nations), alumni groups, farmer organizations, organizations of transporters, manufacturers of farm inputs, processors of farm outputs, banks, and other ruraldevelopment oriented groups.

These linkages may range from informal to highly formalized. For example, relations with extension agencies may be carefully elaborated to ensure a smooth flow of information and no duplication of effort. In contrast, relations with alumni groups may consist of annual informal meetings to provide alumni with a forum in which to make suggestions to faculty on improvements in curricula and to speak to students about career opportunities.

A third essential element for enhancing the role and impact of the SAUs as they move to model three is the use of a strategic planning process to ensure that agricultural research and education programs reflect the real needs of clients and constituents. To accomplish this, the SAU extension services must channel this information into the SAUs. This does not mean providing feedback on adoption of innovations by farmers, but rather translating farmers' needs into researchable topics.

Worldwide, this is an exceedingly difficult goal to achieve. For example, Busch and Lacy (1983) found that agricultural extension in the United States only rarely served in this capacity. In fact, the most effective extension services (and by implication the most effective research organizations) are those that have developed the mechanisms necessary to ensure that the research that farmers want is the research that is being done. The move toward farming systems research is one strategy toward achieving this end. In short, India's farmers must be taken seriously as partners in the development process in order to ensure the success of the SAUs in fulfilling their role.

In this vein, it is also worth noting that early diffusion models of agricultural innovations have misunderstood this important research and extension process. These models suggested that researchers sat in their laboratories and developed new technologies and practices that they thought might be useful to farmers and that, somehow, by virtue of the extraordinary brilliance of scientists, these innovations just happened to be those that farmers (at least the early adopters) wanted.

We now know, however, that this scenario is an extraordinarily rare occurrence. Because scientists are generally not farmers, or at least not typical farmers, they are unlikely to be able to intuit the needs of farmers. Farmers do not simply want higher yielding crops varieties; they want varieties that will yield more under very specific circumstances. These include an economic return (if they are producing for the market), scale economies that fit their particular circumstances, time econonies that fit demands on their time for other farm and nonfarm activities, and toil reduction.

Much more often, in effective research and extension systems, farmers make their needs known to researchers -- by visiting them in their labs, by attending annual field days, and by providing support in the political arena -- and researchers decide which of these needs can be met within a reasonable time and resource horizon. Only the problems that scientists believe can be

resolved become the subject of research. When the research is completed, it provides something for which farmers have long been waiting and hence is rapidly adopted.

It is a curious fact that agricultural students worldwide have rarely been used to help their universities accomplish this end. Although many agricultural universities, including those in India, have introduced practicums for introducing their students to agriculture and rural life, students have not been used to gather information on issues of concern to farmers that research might be able to resolve. Using students in this way would serve the twin goals of both educating them about village life and providing an easy, effective way of ensuring that the university conducts research on topics relevant to the real needs of farmers and rural residents.

One particular advantage that the SAUs have in influencing their environment is through the very technology that they are capable of generating, because technology is an extraordinarily powerful tool for reconstructing the social world (see, for example, Lele and Goldsmith 1986). One need only look at the profound social changes that have accompanied technological innovation (e.g., the Green Revolution) to begin to understand its power. Of course critics of the Green Revolution have, with some accuracy, noted that some of the social changes that occurred as a result of the Green Revolution were undesirable. However, this is because the potential social consequences of the technical changes were not considered conjointly with the technological consequences.

With the lessons of the great strides and mistakes of the Green Revolution behind us, we can now see that India's SAUs have an enormous source of potential power to effect dramatic planned social change. To do so, they must incorporate knowledge from the social sciences concerning the probable social impacts of the planned technological changes. In other words, social scientists cannot merely be brought in to assess the impacts of new technologies after they are developed; they must be involved in the planning for those technologies so that the intended beneficiaries do in fact benefit and the likely socioeconomic consequences are identified in advance.

In conclusion, the SAUs have accomplished much in the short period of their existence. Their very success has created a new range of problems that were only vaguely foreseen at their inception. The challenge facing India's SAUs for the next century will be to complement the concern for the immediate needs of increased production with a greater emphasis on productivity and long-term sustainability; to balance the focus on disciplinary and commodity research with a greater emphasis on interdisciplinary research and a systems perspective; and to move from being reactive organizations to proactive ones, from hierarchical organizations to participatory ones, from agricultural universities to universities for rural development. Given their record so far, we are confident that the SAUs have within them the people who can effect changes of such

great magnitude.

APPENDIX

INDIAN STATE AGRICULTURAL UNIVERSITIES

Name	Year Founded	Enrollment{a}
Andhra Pradesh Agricultural University{b}	1964	2,787
Assam Agricultural University	1969	965
Bidan Chandra Krishi Viswa Vidyalaya (West Bengal)	1974	1,239
Birsa Agricultural University (Bihar)	1980	638
Chandra Shekar Azad University of Agriculture and Technology (Uttar Pradesh)	1975	1,101
Govind Ballabh Pant University of Agriculture and Technology (Uttar Pradesh)b	1960	2,400
Gujarat Agricultural University	1972	570
Haryana Agricultural Universityb	1970	2,403
Himachal Pradesh Krishi Vishva Vidyalaya	1978	832
Indian Agricultural Research Institute (New Delhi)	1958	623b
Indian Veterinary Research Institute (Itznagar)	1889	
Indira Gandhi Krishi Vishwa Vidyalaya (Madya Pradesh)	1987	
Jawaharlal Nehru Krishi Vishwa Vidyalaya (Madya Pradesh)b	1964	2,871
Kerala Agricultural University	1971	
Konkan Krishi Vidyapeeth (Maharashtra)	1972	811
Mahatma Phule Krishi Vidyapeeth (Maharashtra)b	1968	1,776
Marathwada Krishi Vidyapeeth (Maharashtra)	1972	1,725
Mohanlal Sukhadia University (Rajasthan)	1962	7,953
Mysore Agricultural Universityb	1964	

Narendra Deva University of Agriculture
and Technology (Uttar Pradesh) 1975

Orissa University of Agriculture and
Technologyb 1962 2,198

Punjab Agricultural Universityb 1962 2,928

Punjabrao Krishi Vidyapeeth (Maharashtra) 1969 3,300

Rajendra Agricultural University (Bihar) 1970 1,700

Sher-E-Kashmir University of
Agricultural Sciences and Technology
(Jammu and Kashmir) 1982

Tamil Nadu Agricultural University 1971 3,056

University of Agricultural Sciences
(Bangalore, Karnataka) 1964 3,124

University of Agricultural Sciences
(Darwad, Karnataka) 1987

{a} Most recent data available.

{b} Received long-term support from A.I.D. prior to 1973.

Source: Handbook of Indian Agricultural Universities, 1985-86 (1985).

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